SCIENTIFIC AMERICAN SUPPLEMENT. No 1341
Copyright, 1901, by Munn & Co.
Scientific American, established 1845.
Scientific American Supplement. Vol. LII. No. 1341.
NEW YORK, SEPTEMBER 14, 1901.
Scientific American Supplement. $5 a year.
Scientific American and Supplement. $7 a year.

THE VOLCANO OF ÆTNA—INTERIOR OF THE CRATER.

THE CRATER OF ÆTNA IN ERUPTION—VIEW FROM THE OBSERVATORY, SHOWING THE SNOW ON THE LAVA.

MOUNT ÆTNA.

MOUNT ÆTNA is located in the eastern part of Sicily, not far from Catania, and is the loftiest volcano in Europe, as well as the highest mountain in Italy, with the exception of a few of the Northern Italian Alps. Its height is 10,742 feet. The best season for the ascent of Ætna is summer or autumn, from July to September. In spring the snow is a serious obstacle and in winter the guides object to undertaking the ascent. Mules cannot be used beyond the snow line, and an ascent on a moonlight night is desirable, and lanterns may be used in case of need. As the elements are very capricious on the mountain, travelers often have to be satisfied with a view of the crater only. In settled weather when the smoke ascends calmly, and the outline of the mountain is clear, a fine view can be anticipated with tolerable certainty. If, on the other hand, the smoke is driven aside by the wind, which frequently prevails on the summit, the prospect is partially, if not entirely obscured.

There are three different zones of vegetation on the slopes of Ætna. The first is characterized by the presence of cultivated trees, such as the olive, agrumi, the almond and the hazel nut. The next zone, which extends from 3,000 to 6,800 feet, is divided into two regions. The lower of these, from 3,000 to 6,000 feet, is clothed chiefly with evergreens and pines, and the upper, from 6,000 to 6,800 feet, with birches, and a few small groves of oak are also found. Chestnut trees grow from all heights from 1,000 to 1,500 feet. In the highest zones from 6,800 feet to the summit, the vegetation is of the most stunted description. Owing to the scarcity of water and the frequent changes in the surface of the soil, no Alpine flora can exist here, but there is a narrow zone of sub-Alpine shrubs, most of which occur also in the upper part of the wooded region. About forty species of plants are found here. Not a trace of animal life can be detected on the higher portion of the mountain. The bleak, silent waste, glittering in the sunshine, produces an impression seldom forgotten by those who have witnessed it. The present forests of Ætna are a mere fragment of a former splendid belt of timber land. Firs frequently take the place of underwood. The lower slopes of Ætna, owing to the extraordinary fertility of the volcanic soil, are among the most densely populated agricultural districts in the world. The density in the inhabited area is about 930 persons per square mile, and this figure rises to 3,056 persons per square mile in the district between Catania, Nicolosi and Acireale.

The ascent is usually made from Catania, a carriage taking the vistor to Nicolosi. The trip is usually made in the afternoon, so as to have the whole of the following day for the ascent to the observatory. Nicolosi is 2,666 feet above the level of the sea. In three and a half hours journey from this spot Casa del Bosco, 4,715 feet, is reached. In the vicinity, are several small craters formed in 1892. The path then winds through a hollow between smaller extinct volcanoes until about 6,900 feet above the sea it enters the deserted region. The ascent is at first gradual, but becomes steeper and steeper. The traveler passes the hollows filled with snow. In winter the snow is covered with a layer of ashes in order to preserve it for the summer, when it is carried down to the valley for cooling purposes. Finally the Observatory is reached at an elevation of 9,650 feet. Here rooms are reserved for visitors and they are permitted to cook their provisions in the kitchen of the observatory. The latter is usually closed, the custodian visiting it once every week or so to read the recording instruments. The fine dust passes through every crack in the building, so that the rooms are far from clean. Meteorological and seismological instruments are installed as well as a telescope. The observatory lies about 1,000 feet below the summit, which is easily reached in an hour if the sides are free from snow. The form of the crater undergoes constant alteration. At one time it consists of a central abyss two or three miles in circumference; at another it is divided by a barrier into two bays, one of which only emits smoke. The summit itself is usually altered by every eruption. From the highest peak, 10,742 feet, the sunrise, a spectacle of indescribable grandeur, can be witnessed in good weather. The summit is illumined by the morning twilight, while all below is enveloped in profound obscurity. The sun still appears to repose in the sea, which occasionally presents the appearance of a lofty bank of clouds, the horizon being considerably more elevated than the spectator would expect. For some time purple clouds have indicated the point where the sun is about to appear. Suddenly a ray of light flits across the surface of the water, gradually changing to a golden streak, the lower part of which shimmers in intense purple as it widens. The beaming disk then slowly emerges; the mountains of Calabria still cast their long shadows on the sea, the top of Ætna alone is bathed in sunshine. The light gradually descends to the lower parts of the mountain and the dark violet shadow which the vast pyramid casts over Sicily to the west deepens. The outlines of the cone and its summit are distinctly recognized, forming a colossal isosceles triangle on the surface of the island. In a quarter of an hour it is all over and the flood of light destroys the effect produced by the shadows. The deep valleys and the precipitous coast alone remain for a time in obscurity, being shadowed by the lofty mountains. As the sun continues to ascend new points become visible. The spectator stands at the center of the vast circle of 260 miles in diameter and 800 miles in circumference. The Lapari Islands can be seen, but Malta and coast of Africa are beyond the range of vision.

Ætna has been known as a volcano from the earliest ages, and it figures largely in mythology. About eighty eruptions fall within the limits of history. The most violent were those of B. C. 396, 126, 122, and A. D. 1169, 1329, 1530, and 1669. The last of these, one of the most stupendous of all, was the occasion on which Monte Rossi was formed, and 27,000 persons were deprived of all shelter and many lives were lost in the rapidly descending streams of lava. In 1693 an eruption was accompanied by a fearful earthquake which partially destroyed forty towns and caused the loss of 60,000 to 100,000 lives. In the nineteenth century there have been nineteen eruptions, an average of one every four or five years. The most violent were those of 1812, 1819, 1843, 1852, and 1865. The first of these lasted six weeks and the second two months. The most violent recent eruptions were those of 1879 and 1886. The former occurred on the north slope and was accompanied by the unusual phenomenon of a simultaneous outbreak of lava on the west-southwest of the crater, which, however, ceased falling at a height of 6,500 feet. On the north-northeast side the lava first appeared in the crater of 1874. Here, at the height of 4,705 feet above the sea it formed a new crater. The lava poured in large masses from an opening at the foot of this elevation. Its descent was first at the rate of 15 feet per minute, afterward 3 to 6 feet per minute, and finally 30 to 40 feet per hour. In its course it devastated a large tract of cultivated ground. The eruption of 1886 had been threatened since 1883; earthquakes and loud reports followed by a formation of a fissure on the south side of the mountain. This was on the 22d of March, and on the 18th of May the large central crater resumed activity and emitted dense clouds of steam and showers of ashes. Early the next morning a violet earthquake was felt on the south side of the mountain; molten lava poured down the mountain at the rate of 160 to 190 feet per hour. The fury of the eruption reached its height on May 21. The lava continued to fall in the direction of Nocolosi until the inhabitants were panic-stricken. On the 31st of May the Prefect ordered the village to be evacuated, and he guarded the approach to it with soldiers, but on June 2, however, the lava ceased falling within 370 yards of the first house. On the next day the eruption ended with another earthquake. The eruption of 1891 was more important, but as the lava in this case flowed over that of earlier eruptions, the damage to cultivation was slight.

HOW TO INTERPRET THE FACTS OF GEOLOGY.*

I HOLD here a piece of clay (taken from the Bay of Fundy) having all over its surface a series of circular marks or pits that correspond almost absolutely to impressions of certain animals. The specimen shows the pitted form—the raindrop impression—made in the soft mud or clay, and belongs to the most recent geological period. It is rather soft, and therefore not in what probably most of you would consider to be a solid rock; but the geologist considers everything in the nature of what enters largely into the construction of the earth's crust as a rock.

Here is another specimen from the Pemberton marl pits of Burlington County, N. J. What relation have these pits or raindrop impressions to the regular markings in a geological series of hard rocks? We speak of them as fossil raindrops because occurring in a tough, hard rock, the age of which is not less than a few millions of years. We have an abundance of these impressions all through the red rock masses that constitute the north side of the valley immediately north of Chestnut Hill in the trias formation—the same material from which the brownstone fronts of many Philadelphia and New York houses are constructed, and which constitutes the great mass of red mud occupying the northern and central part of New Jersey, as seen at Plainfield and Elizabeth. Thus an old geological fact is interpreted. When we recognize what a recent raindrop is doing and compare the old rocks and their markings with the new clay and sand and its markings, we find a correspondence throughout, though there may have been millions of years elapsing between one and the other.

How are these old impressions preserved through long periods of time? Even in thousands or millions of years they have not been completely obliterated by all those changes taking place over the surface of the earth. While billions of impressions never come to us, a comparatively small number are preserved through a kind of accident for which geologists are not responsible but most thankful.

The close student of land surfaces will have noted how at times the earth becomes suddenly hard; how in this hard earth impressions once produced are retained, new mud is heaped over it, and when we take off the top layer the deeper layer is found retaining its parts. Such as it is, it has gone through all time, from the earliest to the most recent.

The next specimen bears foot-tracks from the Bay of Fundy—claw-like, three forked (instead of rounded pits), corresponding closely to the impressions of wading-birds or perching-birds like the sparrow, the birds leaving the impression in the sand, mud or clay.

In many cases these impressions need not be made by birds. On the surface of the sand at the seashore where there is a little weed or blade of grass projecting through the sand and the retreating water is hurled back across it, it splits the stream of water and makes a triangular valley in front with two or three branches so like the bird impression that in many cases the geologist is in doubt.

There are a number of impressions having this triradiate form unmistakably those of birds; for, in addition to the three lines of toes, it has the impression of the digits and bones of the toes, and in many cases the claws and the scales on the limbs. For half a century there have been large three-toed impressions, six to sight inches in length, of the toes exceedingly abundant in the New England sandstones, especially in the Connecticut Valley, which had been attributed to giant birds related to the ostrich, which itself has only two toes. A very large number of these impressions are made not by birds, but by reptiles, from which it is assumed many birds have descended. The question open in many minds was settled by Prof. Marsh finding along the Connecticut Valley the almost full remains of the actual reptile itself.

Another Bay of Fundy specimen marked by a definite number of pits larger than the raindrops, regular in disposition, with an odd one at intervals scattered about the material. Most persons would say that it was a dog's foot, and be right for anything we know to the contrary. On the other hand—to show how people have been frequently deceived—the next specimen, millions of years old, will immediately suggest a lizard curling over the rock, and it was originally presented to the Academy as a fossil batrachian. It it, however, only the impression of a large seaweed which had become twisted upon itself in this peculiar manner. Nine out of ten laymen, and even a considerable proportion of scientists would have at first pronounced it a batrachian. We constantly receive here specimens purporting to be fossilized human feet, and really having the appearance of feet, yet simply freaks of structure.

Here is a single specimen of breccia—a rock made up of a large number of distinct angular fragments of other rock. Rocks as we find them on the earth's surface do not grow except smaller and smaller—going to destruction—decomposition. But this breccia seems to have grown, yet it is merely a union of fragments through a natural cement—perhaps carbonate of lime—which has united the mass together. All these fragments of angular sides show us plainly that when this rock was made the fragments had been made from other rock very nearly in the place where they occur. The reason for this conclusion is, had these fragments been removed to any great distance, all their sharp corners and sharp edges would have been rounded off and disappeared. Instead of having the angular rocks, we should have one made up of rounded parts, as in this conglomerate or pudding-stone. The only difference between the two is in the roundness of the pebbles in the pudding-stone and the angularity of the pebbles in the breccia. We have the most positive evidence that these pebbles had been worn, moved and migrated before this pudding-stone was made out of them, and equally positive evidence that the breccia was made in the place where we find the rock, from the simple reason that the angles all remained perfectly sharp.

This may seem a trivial thing to you, but to the geologist it is a fact of considerable importance, because, in studying the characteristics of rock masses, it is essential to know from what rock they have been made, from what distance transported, and where they are going to be ultimately carried.

This other specimen of pudding-stone was cemented over a ship's timber wrecked in the ocean fifteen years ago, while that specimen may have been made at a period of hundreds of thousands of years ago, but the general characteristics of the two are precisely the same.

Around Willow Grove you find an abundance of rock having the characteristics of this pudding-stone, and inasmuch as this was formed on the beach line of the New Jersey coast, we have a right to assume that the Willow Grove conglomerate likewise represents a beach deposit, the large extent of which indicates the beach of an old ocean, representing an ocean that came from the western side—from the Pacific. Many millions of years ago the Pacific came to the country lying north and west of us, and there was no indication of the existence of the Atlantic Ocean. Since then the aspect of the country has entirely changed.

Bringing such facts home to us, here is an oyster which I picked up a few years ago on the northern part of the Desert of Sahara, where to-day are only shifting sands and the bases of the Atlas Mountains rising out of them; yet this oyster is one with hundreds of thousands of other oysters occupying the same locality. They are not moving or shifting, as the sands over them, but are planted as a part, and with the solidity, of the country itself. What does this tell us? That the region occupied by this oyster was at one time occupied by the sea. We know of no oyster living, at present or any other time, which inhabited anything else than marine water, or, at least, some water near the mouth of a river which might be said to be brackish in character, consisting of fresh and salt water mixed; so that the interpretation we immediately arrive at is that where this is found, in the northern part of Sahara, oceanic water formerly existed. Other large organisms accompanying this oyster speak exactly the same thing.

At Mullica Hill, N. J., we have an abundance of oysters just as firmly fixed and as positively a part of the rock of the country as this. They prove precisely the same phenomenon—that at the time those oysters were deposited in New Jersey they represented the borderland of that ocean. This period need not have been more than a million years ago—long after the period of the pebbles at Willow Grove, and when the Atlantic Ocean had already existed. It shows where the ocean came and the modifications and changes in the land which received that ocean.

Here is a rock from Phœnixville—the same red rock to which I originally referred as containing the fossil impressions of rainmarks; but this specimen is full of impressions of a curved shell. The Shuylkill River and nearly all the streams of the United States are to-day inhabited by a series of fresh-water fern shells. As far as we can determine from the appearance of these recent shells, and so far as the characters have been obtained of the original fossils, they are so closely alike that we have reason to believe that these fossils at Phœnixville represent the same type of structure as those contained in the Schuylkill River; and that the rock containing these impressions was laid down in fresh water, as distinguished from rock laid down in oceanic water, of which this oyster is the type. These are representatives of two very important classes of rocks recognized by geologists as belonging, one to rocks of marine formation (which constitute by far the largest part of the earth's crust), and the other the rocks of fresh-water formation, which are—comparatively, at least—insignificant, but no less important from the phenomenon explained and the facts they bring to us.

There is a third rock entirely different from the other two; instead of having marine animals (like the oyster) or fresh-water shells, it has implanted nothing but the impressions of leaves, and is known as the terrestrial or earth deposit. While it has an amount of lime formed from the percolation of water like stalactites and stalagmites, yet essentially it is a land deposit, inasmuch as the same kind of rock is found in the various parts of the land surface without connection with an aqueous position, except as represented by the moving skies, by the soils of ponds, by the dust of the roadway.

* Abstract of a lecture delivered at the Academy of Natural Sciences, Philadelphia, by Angelo Heilprin. Specially reported for the SCIENTIFIC AMERICAN SUPPLEMENT.

The root of geological inquiry rests in the interpretation of all the phenomena, and the facts drawn from them, that are being made to-day. When once we are thoroughly acquainted with the working forces of our own time—what they are doing before us and what they have done—we have very nearly the entire key to the explanation of phenomena taking place in past geologic periods.

Here is a mass of sand cemented together by silica (the same substance as the sand itself) into this coarse tube. The explanation of this would be to most of us an exceedingly difficult one, and Alexander von Humboldt was the first to explain it. It is fulgurite—a lightning-stroke rock or a fossil lightning-stroke—from Carroll County, Illinois. The lightning fluid entered the sandy soil and the heat fused the particles of sand in some places; these fused sand masses acted as a cement to other parts not fused, with the result of making this complete structure a fossil, or embodied lightning-stroke. We have exactly the same thing taking place before us; from New Jersey fulgurites are frequently brought in, and we have also a large specimen from the Desert of Sahara.

Another kind of rock surface yields very peculiar shapes and different sizes, represented by this specimen—a rounded mass in regular concentric outline, with central nucleus or pit. There is an almost endless number of forms of this nature called concretions or nodules. How is such concretion formed? How did it acquire its remarkable shape? They duplicate—sometimes triplicate—one another, a freak of nature exceedingly common, but for which no explanation yet given can be considered by the geologist as satisfactory.

The oreodon (upper and lower jaw imbedded in this rock before me) was an intermediate type between the deer and hog, and is retained in almost complete perfection of skeleton. This individual after death became embedded in this rock material from a lake basin or stream, the material entering the space between the upper and lower jaw and making a solid rock, preserving the specimen intact. Since the discovery of this, other specimens have been brought from the Northwest to the Academy complete in every detail to the extremity of the tail and feet bones; but from the first few specimens found the characteristics were determined so clearly that the later finds have not materially changed the original description given the animal.

Here is a fragment of mastodon's tusk from Pemberton, N. J. The mastodon was a tribe of mammals closely related to the elephants and exceedingly abundant in their dispersal throughout Pennsylvania, the Middle West and beyond the Mississippi Valley. The precise species to which this tusk belongs extended almost to the limits of the Arctic region. We are not able to determine physical change in the characteristics of the country since the animal visited these parts. The condition of New Jersey may have been precisely the same when the mastodon wandered around Pemberton as it is to-day; man may have been living; at any rate, the specimen is not more than a few thousand years old.

Upon this rock see the undulations belonging to the former waters that crossed over that land and left the fossil ripple-marks implanted in the rock, representing a period of forty to one hundred million years ago and identical with ripple-marks forming to-day along oceanic waters or in the borders of lake deposits. Another specimen shows in addition to these ripple-marks the raindrop impressions. The oceanic waters made these ripple-marks during a rainfall; not only that, but the same specimen shows a four-toed animal's foot, where the animal crossed this comparatively soft mud or beach and left the impression of its foot. In the same specimen we have raindrop impressions molded into the footprints, and in many cases raindrop impressions effaced by the footprints, telling us absolutely that the animal walked in the rain. Thus we read a history over millions of years, and with just as much positiveness as any history we can read being constructed to-day—as though we were reading a chapter belonging to the historic period.

Here is a glaciated bowlder, representing a part of the rock which at one time was moved over by the floating ice of the glacial stream. The polishing and grooving and the evening-up of the surface was made by the wear and tear of small particles of sand and pebble retained in the ice. The scratches were made through the same process. The northern half of North America bears on its surface evidences exactly similar to those represented in the specimen where, instead of having the single sheet of ice, was the union of a large number of sheets moving separately up in the valleys between the mountains, where they had been formed, and down over the lower levels. In the Adirondacks, on the top of the Palisades, and of the Alleghenies north of Philadelphia, from the Atlantic Ocean into British Columbia, eastward through Great Britain, Scandinavia, the heart of Russia and northern Siberia, was the earth modeled and chiseled on the same plan which this rock depicts.

The single-hand specimen, therefore, is the epitome of the large facts that are apparent to you in the field. The geologist with the true history from the one will read it just as well from the other. The old rocks read to us exactly the same history as the newest; and what is the most pronounced fact is the recognition that the laws that are operating to-day, producing changes in the earth's surface, are precisely the same laws that operated in the earliest parts of the whole range of time millions of years ago—producing exactly the same thing at that time as we see being produced to-day. They may have operated on a more gigantic scale than now; but if they did (and we have no evidence that they did), the kind of work that they did was precisely the same.

THE EROSIVE ACTION OF THE MISSISSIPPI.

"I HAVE been very much impressed with the importance of small things in late years," said an old steamboat man to a New Orleans Times Democrat reporter, "and the Mississippi River has furnished me some rather good examples. I can understand now why Cæsar looked out upon the Nile in such curious amazement, and offered all that he stood for to the Egyptian priest if he would show him the source of that wonderful river. But the antics of the Nile look like insignificant nothings to me when compared with the strange conduct of the stream that oozes out of the earth at Itasca and hurries on its murky and devious way toward the Gulf of Mexico. Towns along the Mississippi that once stood right on the brink of the river have been isolated even in my day, and there are, too, all along the course of the stream little empires in view where the river has encroached upon small centers of population, finally eating the earth away and forcing the inhabitants to seek other quarters. There are hundreds of these places that are almost forgotten now even by men who are constantly on the river. What brings about these violent changes along the banks of the river? Not floods. It is just the ordinary doings of the stream. In the first place the current of the Mississippi is wonderfully swift, and the sediment deposited at any point where resistance to the flow is offered is very great. Tie a string to the neck of a bottle and sink it with the mouth of the bottle up and open. If held in one place where the flow is normal in an extremely short period of time the bottle will fill with sediment. Stretch a net across the river, a net so finely woven that nothing but the pure water of the river can pass through, and, on account of the rapidity of the flow and the greatness of the deposit of sediment, almost in a twinkling the river would be dammed at that point. Experts have admitted this. This brings me to the point of my narrative. The flow of currents is frequently interfered with by sunken boats, perhaps by a jackstaff sticking up above the surface. The current is diverted by degrees, generally touching the far side of the stream a mile from the point where it again meets resistance and immediately begins the building of a sandbar. I have seen a thousand examples of this sort during my career on the river, and I have known of instances where the root of a tree or the mere twig of a willow has brought about similar conditions. These things have tended to make a riddle out of the river, yet the stream after a while will be handled so as to undo all that it has accomplished in this way."

SVEN HEDIN'S EXPLORATION IN CENTRAL ASIA.

THE following interesting account of Dr. Sven Hedin's second expedition in Central Asia appears in The London Times:

"It will be remembered that Dr. Hedin traveled down the Yarkand and Tarim rivers to the Lob Nor region, in which he made many excursions of the greatest value to geographical science. But what delighted him most was the very important discovery he made of an ancient lake bed which strongly confirmed the theory he advanced after his first journey in Central Asia—that the ancient Lob Nor Lake was not identical with the lake which commonly bears that name at the present day. Writing from Tiumen (Temirlik) at the end of last October Dr. Hedin announced his intention of making two more journeys before he set out on the long march home, one among the mountains to the west of Temirlik, the other to the ancient lake bed he had discovered and the Kara-Koshun Lake, which he identified with Prjevalsky's Lob Nor. It is with these two expeditions that his latest letters deal.

"Starting on the first journey, to the great or westerly Kum-Kul, early in November, Dr. Sven Hedin crossed and measured these mountains on three lines. He passed through absolutely unknown country, but the excursion was a comparatively short one, lasting only a month, and by December 12 he was ready for the more important march. On this he had with him nine men and eleven camels and ten horses. Khan-ambal was the first point for which he made, and this he reached by a rather difficult mountain road, lying to the south of Littledale's road, which was struck at Khan-ambal. After making a circular march to Sirting, round the magnificent Anambar-ula, and back to Khan-ambal, Dr. Sven Hedin proceeded across the desert straight to the north, and passed through the mountainous region which constitutes the western continuation of the Kurruk Tagh. He was able to map the whole of his route from Temirlik, and found that the existing maps were quite incorrect.

"During the latter part of the march the little company of travelers had a very trying experience. For twelve long and arduous days, during which they pushed forward as rapidly as possible and covered, in spite of the slow rate of traveling necessitated by the careful observations which Dr. Sven Hedin was continually taking, about twenty miles a day, not a drop of water was found. Fortunately, on the third day the travelers came across some snow, and this just enabled the camels to last out until water was reached; otherwise they must inevitably have succumbed. After this Dr. Hedin, with the aid of the map he had compiled in March, 1900, when he made his great discovery in connection with the Lob Nor problem, was able to find Altimishbuluk quite easily, and from there to proceed with all his caravan to the ruins on the northern shore of the ancient lake bed. The camels were heavily laden with ice, and after they had been sent back to the 'bulak,' Dr. Hedin was able to stay among the ruins for a week. During this time he was busily engaged compiling maps and plans, taking photographs, gathering together collections of various kinds and making excavations among the ruins. The discoveries he made were both numerous and important, but he thinks that perhaps his most curious 'find' was some twelve complete letters written on paper in Chinese. They were in a marvelous state of preservation, every sign being perfectly distinct and legible. Among other curiosities that Dr. Sven Hedin will bring home are thirty little pieces of wood, which, so far as he can judge at present, must have been used as some kind of ticket. Each one has inscribed on it the name of some Emperor, the year of his reign, the month, and even the very day. A 'siah' who has read some of them tells Dr. Hedin that they are 800 years old, but the latter feels that he cannot form a definite opinion until he has had them translated on his return.

"Among the ruins Dr. Hedin found a beautiful Buddhist temple, in which he saw some most artistic wood carving. One of the representations was a large fish, and in this connection he mentions that one house contained a number of fish bones which were evidently the remains of fish exactly similar to those found to-day in the Kara-Koshun Lake to the south. These facts Dr. Sven Hedin considers important as strengthening his claim to have found a lake bed which was actually filled not so many years ago, and which is the true site of the Lob Nor of the ancients. In the temple Dr. Hedin further found a Buddha, carved in wood; and he also mentions as one of his 'finds' a piece of wood which he describes as being about half the size of the sheet of notepaper he was writing on, on which there was writing in Thibetan characters. In one of the Chinese letters, to which reference has already been made, the place is called Lo-län, and there is also mention of the great road which it will be remembered Dr. Sven Hedin found running along the northern shore of the lake bed, which is said to join Lo-län to Sa-dscheo. Dr. Hedin brought away with him specimens of the various kinds of wood-carving, and students in Europe will eagerly await the sight of these as well as of the photographs of the ruins which Dr. Hedin had developed just before writing and of which he speaks in the most enthusiastic terms.

"Of the full importance of his discoveries among the ruins it is, he says, impossible to give at present any adequate idea, but he states that he has gathered together materials for a bulky volume on the Lob Nor problem alone. He is particularly pleased that, on leaving the ruins, he was able to take observations which have enabled him to draw the 'leveling' line between the northern shore of the ancient lake bed and the northern shore of Lake Kara-Koshun, or, in other words, to ascertain the variations in level between these two points. These observations, he is convinced, have afforded him the best argument he could possibly have to show that he has found the true solution of the Lob Nor problem. He found that the ruins on the northern shore of the ancient lake bed were situated at a level 2,272 meters higher than that of the surface of Lake Kara-Koshun, but that the lowest point of the lake bed lay about as much below the same surface. Between the lake bed and the lake the desert rises to a point somewhat higher than the ruins. Dr. Sven Hedin states that his observations will enable him to determine not only the surface dimensions of the old lake bed, but also the lines of depth. It has just been mentioned that the lower half of the ancient lake bed is lower than the surface of the Kara-Koshun Lake, and Dr. Hedin reports that the water in the latter is now finding a passage to the old basin. When Dr. Hedin was making his explorations in this part the waters of the present lake were spreading north so rapidly that it was unsafe for the travelers to camp on the shore.

"At the date of the letter in which he described these interesting researches (April 23 of this year), Dr. Sven Hedin was at Charkhlik, which he had reached only a few days earlier. He was greatly surprised to learn from the letters he found awaiting him about the troubles in China (he himself had been traveling in a portion of the Chinese Empire!), and somewhat amused at the warnings addressed to him by King Oscar, the Swedish Minister for Foreign Affairs, and numerous other friends, to the effect that he should be careful not to expose himself to the cruelty of the Chinese, while he laughed at the idea that he might be compelled to leave his work unfinished and return to Europe at once.

"In Charkhlik, he says, though it is a town in the middle of the Celestial Empire, there are only fifteen Chinese, and these were mortally afraid of him and his Russian escort of four Cossacks. They did everything he commanded, procuring camels, horses and provisions for him without delay, and otherwise carrying out his behests with the greatest promptitude. Dr. Sven Hedin's next line of march will be through Thibet, and there, of course, as he remarks, there are no Chinese.

"Looking back over his work from Charkhlik, Dr. Sven Hedin is fully satisfied with the results he has obtained. He has followed a different plan of work from that which he pursued on his first expedition in 1893-97. Then he not only took observations and made notes, but also worked at the books he intended to publish on his return. On this expedition he has done nothing of the latter kind of work, but has left it all to be done when he reaches home. He had already, when writing, compiled 726 sheets of maps, 150 of them large sheets.

"He calculates that he has more than twice the cartographical material he accumulated on his last expedition, and hopes to be able to publish it in a large atlas of some sixty or seventy maps on a scale which will permit of the details being shown. The scientific results of all his geographical, geological and hydrographical studies he proposes to publish in two large volumes, of 500 pages each, which will form a text to the atlas. Dr. Hedin has such a wealth of material to draw upon that he will find it very difficult to compress the popular narrative which he hopes to publish into two moderate volumes. He hopes, however, to do so.

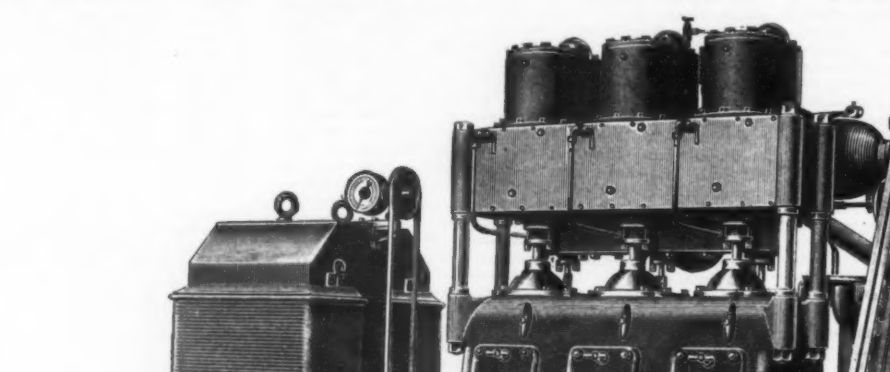
"As to his future plans, Dr. Hedin does not now think that he will reach Europe this year. When writing last he proposed to spend some eight or ten days at Charkhlik, and then, having prepared his caravan very carefully for the last stage of his great journey, to cross Thibet diagonally from Temirlik to the sources of the Indus, passing, if possible, a little to the north of Lake Manasarowar. As he travels slowly and maps carefully, Dr. Sven Hedin expects that this march will occupy the rest of this year. If it can be arranged he would like to visit Lord Curzon in Calcutta; then, returning to his caravan, proceed as quickly as possible to Kashgar via Ladak. He intended to send all his collections and unnecessary luggage—fifteen horses' load—direct to Kashgar from Charkhlik. From Kashgar Dr. Hedin does not feel that he could return direct to Europe on account of his Cossacks, who have rendered him invaluable services, and to whom he has become quite attached; these he feels bound to leave in none but a Russian town. Altogether, therefore, it will be about a year from the date of his last letters before European geographers can receive Dr. Sven Hedin with the welcome which he has so well earned."

THE "PEACHE" HIGH-SPEED ENGINE AT THE GLASGOW EXHIBITION.

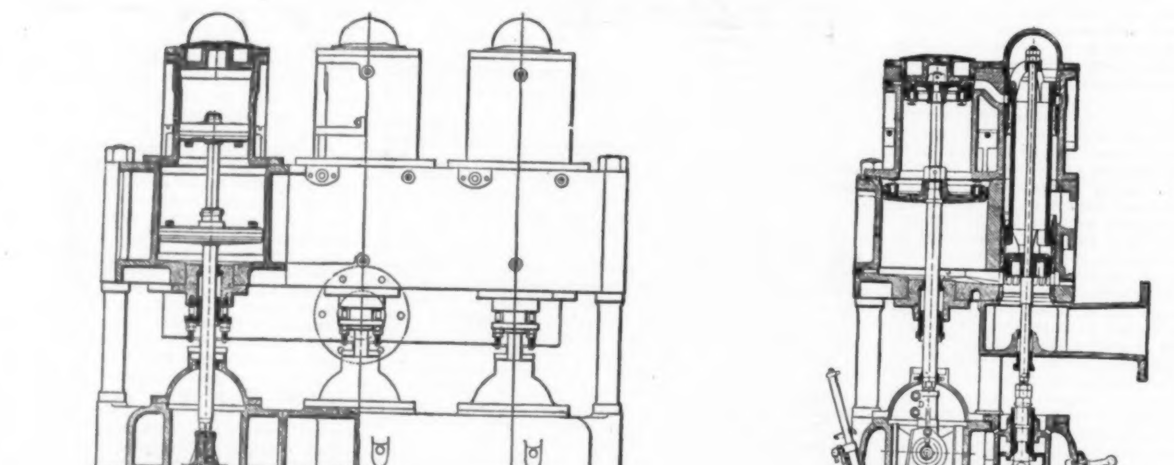
Messrs. Davey, Paxman & Company, of Colchester, exhibit a good example of one of their 360 indicated horse power high-speed engines, of which we give an external view and section illustration. The engine is of the single-acting type; that is to say, the balance of pressure is always exerted as a thrust, so that there is no backlash in the bearings.

The high-pressure steam chest consists of the annular space round the main body of the valves, and is situated partly in the high-pressure cylinder casting over the top of the low-pressure valve, to the underside of the low-pressure piston, and finally it is exhausted under the lower edge of the low-pressure valve, to the exhaust chamber. In the bore of the high-pressure cylinder are cut two small by-pass ports over which the high-pressure and low-pressure pistons pass at the top of their stroke, thus placing the space between the high-pressure and low-pressure pistons in direct connection with the upper side of high-pressure piston. This space, which is called the controlling cylinder, is thus at the top of the stroke filled with steam at approximately the same pressure as that in the high-pressure cylinder. On the downstroke this the steam in the controlling cylinder and in displacing the steam under receiver pressure from the high-pressure cylinder. The work thus done in compressing steam in the controlling cylinder is given out again by its expansion on the next downstroke, and the work done in transferring steam under pressure from the high-pressure cylinder to the receiver is utilized in the low-pressure cylinder.

It will be noticed that the valves are always subject to receiver pressure, which tends to maintain them in constant downward thrust; this, however, is not quite sufficient to overcome the inertia of the valve and its motion at the top of the stroke, and to supply this



"PEACHE" HIGH-SPEED ENGINE COUPLED TO MULTIPOLAR DYNAMO BY THE GENERAL ELECTRIC COMPANY.



SECTIONAL VIEWS OF DAVEY-PAXMAN "PEACHE" HIGH-SPEED ENGINE.

and partly in the low-pressure cylinder casting. Steam from the throttle valve passes to a branch on the low-pressure cylinder casting, connected by passages in that casting to the three high-pressure steam chests. This construction has been adopted in order to permit of any high-pressure cylinder being removed without breaking any joint besides that between the high-pressure and low-pressure cylinders.

Following the distribution of steam to the cylinders: Steam passes under the edge of the high-pressure valve to the top of the high-pressure piston, and is exhausted over the top of the high-pressure valve, down through the center of the main body of the valve, and thence steam expands, and on the upstroke it is compressed until it reaches the pressure of the steam in the high-pressure cylinder, any small loss that may occur by leakage being made good by fresh steam passing from this cylinder.

The function of this controlling cylinder is to effect a balance of the upward inertia force of the pistons, crossheads, connecting rod, etc., on the upstroke; that is, to keep a slight excess of pressure in a downward direction throughout the upstroke. Thus, on the upstroke, the steam acts on the underside of the low-pressure piston, but, instead of being allowed to act direct on the crank, it does work in compressing deficiency an air-buffer cylinder is employed; this is fixed in the working chamber.

The crank shaft is placed out of line with the cylinders. The reason for adopting this position is that it gives a nearly straight connecting rod during the downward working stroke, when the pressures are greatest, and keeps what pressure is due to the angle of the connecting rod on the back crosshead slide. On the upstroke, when the angle of the connecting rod is greater, the downward pressures are only sufficient to balance the inertia forces of the reciprocating parts, and therefore, although the angle of the connecting rod is considerable, the pressure transmitted to the

crosshead slide is small, and what there is is still on the back slide. Thus the crosshead is kept always pressed against the back slide, and thus avoids any tendency to knock.

The valves are worked from a point on the connecting rod by means of a rod and rocking lever. These, as well as the main parts, are kept in constant thrust. This valve motion brings the valves into a convenient position, viz., at the back of the steam cylinders, so that the cylinder centers can be brought close together. At the same time, there being no eccentrics on the crank shaft, ample room is left for long and well-supported bearings. The valve motion itself gives a better distribution of steam than could be obtained with an eccentric, viz., quick opening and cut-off in the high-pressure cylinder, later cut-off in the low-pressure cylinder, and very free and ample exhaust opening for the low-pressure cylinder.

The lubrication is on the splash system, and a gage tank at the back of the base shows the height of the lubricant bath.

The steam cylinders are supported on four wrought-iron columns, and thus entirely isolated from the working chamber. This construction has two important advantages. First, heat cannot pass from the steam cylinders to the lubricant bath, and thus overheat and decompose it. Second, when running on a condenser, oil from the working chamber cannot be sucked up through the glands into the cylinders, and thus get to the condenser and boilers.

The governor is of the centrifugal type, with the main springs connected directly across from one ball to the other, so that the friction of the governor is kept down to a minimum, the pins having only to carry the small pressures which come upon them from the actual work of moving the throttle valve. The governor is capable of controlling the speed of the engine at all loads within 1 per cent of the normal, and the normal speed can be adjusted by hand while the engine is running by as much as 30 per cent without affecting the above-mentioned error.

The engine is coupled to a multipolar dynamo made by the General Electric Company, Ltd., of London and Manchester. The duty is 420 amperes at any voltage from 460 to 500 on lighting load, and 500 to 550 volts, 300 amperes on traction load. These dynamos can be overloaded 20 per cent on lighting load, and 25 per cent on traction load. The machine is, of course, overcompounded for traction work, the compounding being cut out for lighting service. The magnet frames of the generator are divided on the horizontal diameter, and have especially light fields and yokes much resembling the typical American standard. The pole pieces and field coils are of cylindrical shape. The armature is of the flywheel type of large diameter, with slotted core. The carbon brushes can be retained in fixed position, and run sparklessly from no load to 25 per cent overload.—The Mechanical Engineer.

MACHINE FOR RAISING WATER BY THE METHOD OF ARCHIMEDES' SCREW.

THE current of a river or stream is used to move the water wheel, *B*, which in turn operates the lantern wheel, *D*, by the toothed wheel shown at one end of its axle. *D*, being fast on the vertical shaft shown in the illustration, turns it, and the lantern wheel, *E*, which is also fast on the shaft. *E* drives the toothed wheel, *F*, which, by means of a double row of pegs (one row on each side) drives the two shafts on which the pipe is coiled, in opposite directions. The pipe is coiled in opposite directions also about the two shafts, so as to make both coils have a raising effect. The water enters at the lower end of the coils, and as they revolve it is gradually raised till it flows out into the reservoir at the top.—Recueil d'Ouvrages Curieux de Mecanique et de Mathematique.

THE LIVERPOOL MOTOR-VEHICLE TRIALS.

IN the development of motor vehicles different countries appear to have taken up different portions of the problem, not by any sort of agreement, but rather from the influence of local conditions. In France the pleasure and touring vehicles have reached a high degree of elaborateness, and in the recent race from Paris to Berlin we see the natural result of what must be considered a one-sided development. Another development, also one-sided, perhaps, and on the opposite side from that seen in France, is found in the trials of the Liverpool Self-Propelled Traffic Association. Here it is the motor truck and lorry, for carrying heavy merchandise in competition with horse-drawn vehicles, which have received attention, and as a result of these trials it is not too much to say that England has surpassed all other countries in the development of motor vehicles for heavy traffic.

It is now two years since trials of motor cars have been held by the association, and hence those recently concluded have attracted much attention. This was more especially the case since it was intended that demonstrations would be made which should influence the Local Government Board to consider favorably the proposal to modify the present regulations, under which the maximum tare weight of vehicles must not exceed three tons. At the previous trial all the competing vehicles have been kept within this limit, and the result has been beneficial to the extent of causing great care to be exercised in the use of material and the distribution of weights.

This year, however, in addition to the smaller cars, arrangements were made for the trial of two new classes of cars on which no tare limit was fixed, the object being to show the feasibility of extending the limit to a desirable point beyond the present rules.

A full report of the trials and description of the vehicles taking part therein is given in the Automotor Journal, from which some abstracts are made.

Among the especial requirements in the general regulations we note the following: In addition to the ordinary demands upon motor vehicles, the cars entered for trial shall have sufficient water capacity for a run of 15 miles, shall be capable of starting from rest on a gradient of 1 in 9, and shall be capable of working in and out of an embayment of one and a half times their own lengths. No restriction is made as to the character of motive power, or the nature of the agents used, but with the exception of Class C, in which no tare limit is imposed, all vehicles must comply with the Locomotives on Highways Act, 1896. Limiting dimensions and weights are also given for the various classes, as well as the speeds, which are 8 miles per hour for Class A, of 1½ tons load and 2 tons maximum tare, and 5 miles per hour for the heavier vehicles.

Space does not permit of a detailed description of the various vehicles which entered in the trials, and the reader must be referred for details to the original report. A few general remarks, however, will give some idea of the character of the various cars. In the trials of 1899, all the vehicles entered were propelled by steam power, and it then appeared that this was the only feasible kind for such service. In the present trials, however, there were two petroleum motors, both of which worked well, although being of the same design, they gave no opportunity for comparison.

In the case of the steam cars, the general design was the same in all, the boiler being forward and the water-tank behind. The details varied greatly, vertical water-tube, vertical fire-tube, locomotive, and flash boilers all being in use. The steam engines were generally of the two-cylinder compound type, with provision for the use of high-pressure steam in both cylinders for starting or overcoming heavy resistance. Single-acting high-pressure engines were also employed in connection with flash boilers. All vehicles were fitted with change gears, giving two changes, these being engaged either by sliding the teeth in and out of mesh, or by the use of clutches, it being necessary to shut off steam while changing gear.

Freedom of action between the sprung and unsprung portions of the gear is obtained either by chain connection or by universal joints; the differential gear in all cases being arranged so as to be readily locked. With but one exception the Ackermann steering method was employed, this machine having also no differential gear, but using a separate engine for driving each rear wheel. An independent reserve method of feeding the boiler appeared in each case, and condensers were not found on any of the competing vehicles.

"Throughout these steam wagons, one cannot but be struck by the enormous improvements which have been made both in their construction and in their capabilities; the majority of them bear ample evidence to the fact that heavy road vehicles have now been brought to a stage at which they are entirely suited for continuous and reliable duty under any of the usual working conditions, and at which minor improvements only may be expected in the future. In the matter of serious vibration, even when traveling over the worst roads, all the cars were remarkably free from this; even fragile goods could evidently be carried without fear of breakage, if they were packed with reasonable care."

The report, although only that of the publication referred to, and to be supplemented by the official report of the judges, shows that the requirements were by no means too difficult of accomplishment, the details of the various trials showing the success with which they were met. Awards were made to all the vehicles in all classes except Class D, which was held under advisement.—The Engineering Magazine.

WATER-RAISING MACHINE CONSTRUCTED ON THE PRINCIPLE OF ARCHIMEDES' SCREW.

GOLD SUPPLY AND HISTORY.

IN a recent number of the North American Review a well-known writer sets forth that there are only two periods in the history of the money metals that can be compared to the present, and to which we may look for any experimental light upon the subject. One of these was the period following the discovery of America and the exploitation of the treasures of Mexico and Peru, and the other the period following the discoveries in California and Australia. In the period of 150 years following the discovery of America the depreciation of the metals was about two-thirds of their value; that is, in 1650 a given amount of gold or silver brought only about one-third as much as in 1500. The result naturally was extreme confusion in affairs, great suffering among wage-earners and embarrassment to all whose incomes were fixed in terms of money. The "poor laws" of Queen Elizabeth's time have been attributed to the distress caused by the rise of food without equivalent compensation to the wage-earning class. The quarrel of Charles I. with Parliament was undoubtedly aggravated by the necessity for new taxes to overcome the declining value of the revenues, and some historians hold that it was the deadly money question, the bane of politicians in all ages, that cost him his head. Gold was discovered in California in 1848 and in Australia in 1851, and by 1852 these new fields were producing together over $100,000,000 a year. The first sign of the influx of the new gold into Europe was seen in

the holdings of the Bank of England. They went up from about $40,000,000 in 1847 to $110,000,000 in June, 1853. To get this idle money into use the bank reduced its regular rate of discount to 2 per cent, and the market rate for a considerable time was reported at 1½ per cent. The belief that the new supplies of gold would effect a permanent reduction at this rate of interest was so general that Mr. Gladstone, then Chancellor of the Exchequer, proposed in Parliament a scheme to refund the consols below 3 per cent and fixed the rate on exchequer bills at 1½ per cent.

THE PROGRESS OF SCIENCE.*

By R. S. WOODWARD.

A CONSTITUTIONAL provision of our association stipulates that "It shall be the duty of the president to give an address at a general session of the association at the meeting following that over which he presided." Happily for those of us who must in turn fulfill this duty, the scientific foresight of our predecessors set no metes and bounds with respect to the subject-matter or the mode of treatment of the theme that might be chosen for such an address. So far, therefore, as constitutional requirements are concerned, a retiring president finds himself clothed for the time being with a degree of liberty which might be regarded as dangerous were it not for an unwritten rule that one may not hope to enjoy such liberty more than once. But time and place, nevertheless, as well as the painful personal limitations of any specialist, impose some rather formidable restrictions. One may not tax lightly, even, in a summer evening, the patience of his audience for more than an academic hour, the length of which in most cases is less than 60 minutes. One must confine himself to generalities, which, though scientifically hazardous, serve as a basis for semi-popular thought; and one must exclude technical details, which, though scientifically essential, tend only to obscure semi-popular presentation. Courtesy, also, to those who are at once our hosts and our guests requires that, so far as possible, one should substitute the vernacular for the "jargon of science," and draw his figures of speech chiefly from the broad domain of every-day life rather than from the special, though rapidly widening, fields of scientific activity.

Between this nominally unlimited freedom on the one hand and these actually narrow restrictions on the other, I have chosen to invite your attention for the hour to a summary view of the salient features of scientific progress, with special reference to its effects on the masses, rather than on the individuals, of mankind. We all know, at least in a general way, what such progress is. We are assured almost daily by the public press and by popular consent that the present is not only an age of scientific progress but that it is pre-eminently the age of scientific progress. And with respect to the future of scientific achievement, the consensus of expert opinion is cheerfully hopeful and the consensus of public opinion is extremely optimistic. Indeed, to borrow the language sometimes used by the rulers of nations, it may be said that the realm of science is now at peace with all foreign parts of the world, and in a state of the happiest domestic prosperity.

But times have not been always thus pleasant and promising for science. As we look backward over the history of scientific progress it is seen that our realm has been taxed often to the utmost in defense of its autonomy, and that the present state of domestic felicity, bordering on tranquillity, has been preceded often by states of domestic discord bordering on dissolution. And, as we look forward into the new century before us, we may well inquire whether science has vanquished its foreign enemies and settled its domestic disputes for good and all, or whether future conquests can be made only by a similarly wasteful outlay of energy to that which has accompanied the advances of the past. Especially may we fitly inquire on an occasion like the present what are the types of mind and methods of procedure which make for the progress, and what are the types of mind and methods of procedure which make for the regress, of science. And I venture to think that we may inquire also with profit, in some prominent instances, under what circumstances in the past science has waxed or waned, as the case may be, in its slow rise from the myths and mysticism of earlier eras to the law and order of the present day. For it is a maxim of common parlance, too well justified, alas! by experience, that history repeats itself; or, to state the fact less gently, that the blunders and errors of one age are repeated with little variation in the succeeding age. This maxim is strikingly illustrated by the history of science, and it has been especially deeply impressed upon us—burnt in, one might say—by the scientific events of our own times. Have we not learned, however, some lasting lessons in the hard school of experience, and may we not transmit to our successors along with the established facts and principles of science the almost equally well established ways and means for the advancement of science? Will it be possible for society to repeat in the twentieth century the appalling blunders of the nineteenth century; or, have we entered on a new era in which, whatever other obstacles are pending, we may expect man to stand notably less in his own light as regards science than ever before? To a consideration of these and allied questions I beg your indulgence, even though I may pass over ground well known to most of you, and encroach, perhaps, here and there, on prominences in fields controversial; for it is only by discussion and rediscussion of such questions that we come at last, even among ourselves in scientific societies, to the unity of opinion and the unity of purpose which lead from ideas to their fruitful applications.

From the earliest historic times certainly, if not from the dawn of primitive humanity, down to the present day, the problem of the universe has been the most attractive and the most illusive subject of the attention of thinking men. All systems of philosophy, religion, and science are alike in having the solution of this problem for their ultimate object. Many such systems and sub-systems have arisen, flourished, and vanished, only to be succeeded by others in the seemingly Sisyphean task. Gradually, however, in the lapse of ages there have accumulated some elements of knowledge which give inklings of partial solutions; though it would appear that the best current opinion of philosophy, religion, and science would again agree in the conclusion that we are yet immeasurably distant from a complete solution. Almost equally attractive and interesting, and far more instructive, as it appears to me, in our own time, is the contemplation of the ways in which man has attacked this perennial riddle. It is, indeed, coming to be more and more important for science to know how primitive, barbarous, and civilized man have visualized the conditions of, and reached his conclusions with respect to, this problem of the centuries; for it is only by means of a lively knowledge of the baseless hypotheses and the fruitless methods of our predecessors that we can hope to prevent history from repeating itself unfavorably.

Looking back over the interval of two to three thousand years that connects us by more or less authentic records with our distinguished ancestors, we are at once struck by the admirable confidence they had acquired in their ability to solve this grand problem. Not less admirable, also, for their ingenuity and for the earnestness with which they were advanced, are the hypotheses and arguments by which men satisfied themselves of the security of their tenets and theories. Roughly speaking, it would appear that the science of the universe received its initial impulse from earliest man in the hypothesis that the world is composed of two parts; the first and most important part being in fact, if not always so held ostensibly, himself, and the other part being the aggregate of whatever else was left over. Though dimly perceived, and of little account in its effects, this is, apparently, the working hypothesis of many men in the civilized society of to-day. But the magnitude of the latter part and its inexorable relations to man, seem to have led him speedily to the adoption of a second hypothesis, namely, that the latter part, or world external to himself, is also the abode of sentient beings, some of a lower and more of a higher order than man; their function tending on the whole to make his sojourn on our planet tolerable and his exit from it creditable, while yet wielding at times a more or less despotic influence over him.

How the details of these hypotheses have been worked out is a matter of something like history for a few nationalities, and is a matter absorbing the attention of anthropologists, archæologists, and ethnologists as it concerns races in general. Without going far afield in these profoundly interesting and instructive details, it may suffice for the present purposes to cite two facts which seem to furnish the key to a substantially correct interpretation of subsequent developments.

The first of these is that the early dualistic and antithetical visualization of the problem in question has persisted with wonderful tenacity down to the present day. The accessible and familiar was set over against the inaccessible and unfamiliar; or, what we now call the natural, though intimately related to, was more or less opposed to the supernatural; the latter being, in fact, under the uncertain sway of, and the former subject to the arbitrary jurisdiction of, good and evil spirits.

The second fact is that man thus early devised for the investigation of this problem three distinct methods, which have likewise persisted with equal tenacity, though with varying fortunes, down to the present day. The first of these is what is known as the à priori method. It reasons from subjective postulates to objective results. It requires, in its purity, neither observation nor experiment on the external world. It often goes so far, indeed, as to adopt conclusions and leave the assignment of the reasons for them to a subsequent study. The second is known as the historico-critical method. It depends in its purity on tradition, history, direct human testimony, and verbal congruity. It does not require an appeal to Nature except as manifested in man. It limits observation and experiment to human affairs. The third is the method of science. It begins, in its elements, with observation and experiment. Its early applications were limited mostly to material things. In its subsequent expansion it has gained a footing in nearly every field of thought. Its prime characteristic is the insistence on objective verification of its results.

All of these methods have been used more or less by all thinking men. But for the purposes of ready classification it may be said that the first has been used chiefly by dogmatists, including especially the founders and advocates of all fixed creeds, from the atheistic and pantheistic to the theistic and humanistic; the second has been used chiefly by humanists, including historians, publicists, jurists, and men of letters; and the third has been used chiefly by scientists, including astronomers, mathematicians, physicists, naturalists, and more recently the group of investigators falling under the comprehensive head of anthropologists. The first and third methods are generally held to be mutually antithetical, if not mutually exclusive. The second occupies middle ground. Together they are here set down in the order of their early development and in the order of their popularly esteemed importance during all historic time previous to, if not including, this first year of the twentieth century.

No summary view of the progress of science, it seems to me, can be made intelligible except by a clear realization of these two facts, which may be briefly referred to as man's conception of the universe and his means of investigating it. What, then, in the light of these facts, has been the sequel? The full answer to this question is an old and a long story, now a matter of minute and exhaustive history as regards the past twenty centuries. I have no desire to recall the dramatic events involved in the rise of science from the Alexandrian epoch to the present day. All these events are trite enough to men of science. A mere reference to them is a sufficient suggestion of the existence of a family skeleton. But, setting aside the human element as much as possible, it may not be out of place or time to state what general conclusions appear to stand out plainly in that sequel. These are our tangible heritage and upon them we should fix our attention.

In the first place, the progress of science has been steadily opposed to, and as steadily opposed by, the adherents of man's primitive concepts of the universe. The domain of the natural has constantly widened and the domain of the supernatural has constantly narrowed. So far, at any rate, as evil spirits are concerned, they have been completely cast out from the realms of science. The arch fiend and the lesser princes of darkness are no longer useful, even as an hypothesis. We have reached—if I may again use the cautious language of diplomacy—a satisfactory modus vivendi if we have not attained permanent peace in all our foreign relations. Enlightened man has come to see that his highest duty is to co-operate with Nature, that he may expect to get on very well if he heeds her advice, and that he may expect to fare very ill if he disregards it.

Secondly, it appears to have been demonstrated that neither the à priori method of the dogmatists nor the historico-critical method of the humanists is alone adequate for the attainment of definite knowledge of either the internal or the external world, or of their relations to one another. In fact, it has been shown over and over again that man cannot trust his unaided senses even in the investigation of the subject and most obvious material phenomena. There is an ever-present need of a correction for personal equation. Left to himself, the à priori reasoner weaves from the tangled skein of thought webs so well tied by logical knots that there is no escape for the imprisoned mind except by the rude process applied to cobwebs. And in the serenity of his repose behind the fortress of "liberal culture" the reactionary humanist will prepare apologies for errors and patch up compromises between traditional beliefs and sound learning with such consummate literary skill that even "the good demon of doubt" is almost persuaded that if knowledge did not come to an end long ago it will soon reach its limit. In short, we have learned, or ought to have learned, from ample experience, that in the search for definite, verifiable knowledge we should beware of the investigator whose equipment consists of a bundle of traditions and dogmas along with formal logic and a facile pen; for we may be sure that he will be more deeply concerned with the question of the safety than with the question of the soundness of scientific doctrines.

Thirdly, it has been demonstrated equally clearly, and far more cogently, that the sort of knowledge we call scientific, knowledge which has in it the characteristics of immanence and permanence, is founded on observation and experiment. The rise and growth of every science illustrate this fact. Even pure mathematics, commonly held to be the à priori science par excellence, and sometimes called "the science of necessary conclusions," is no exception to the rule. Those who would found mathematics on a higher plane have apparently forgotten to consider the contents of the mathematician's waste-basket. The slow and painful steps by which astronomy has grown out of astrology, and chemistry out of alchemy; and the faltering, tedious, and generally hotly-contested advances of geology and biology, have been made secure only by the remorseless disregard which observational and experimental evidence has shown for the foregone conclusions of the dogmatists and the literary opinions of the humanists. Thus it has been proved by the rough logic of facts and events that the rude processes of "trial and error," processes which many philosophers and some men of science still affect to despise, are the most effective means yet devised by man for the discovery of truth and for the eradication of error.

These facts are so well known to most of you, so much a matter of ingrained experience, that the categorical mention of them here may seem like a rehearsal of truisms. But it is one of the paradoxes of human development that errors which have been completely dislodged from the minds of the few may still linger persistently in the minds of the many, and that the misleading hypotheses and dead theories of one age may be resuscitated again and again in succeeding ages. Thus, to cite one of the simplest examples, it doubtless appeared clear to the Alexandrian school of scientists that the flat, four-cornered earth of contemporary myths would speedily give way to the revelations of geometry and astronomy. How inadequate such revelations proved to be at that time is one of the most startling disclosures in all history. The "Divine School of Alexandria" passed into oblivion. The myth of a flat and four-cornered earth was crystallized into a dogma strong enough to bear the burden of men's souls by Cosmas Idicopleustes in the sixth century; it was supported with still more invincible arguments by Martin Luther in the sixteenth century; and it was revived and maintained with not less truly admirable logic, as such, by John Hampden and John Jasper in the last decades of the nineteenth century. To cite examples from contemporary history showing how difficult it is for the human mind to get above its primitive conceptions, one needs only to refer to the daily press. During the past two months, in fact, the newspapers have related how multitudes of men, women, and children, many of them suffering from loathsome if not contagious diseases, have visited a veritable middle-age shrine in the city of New York, strong in the hoary superstition that kissing a relic of St. Anne would remove their afflictions. During the same interval a railway circular has been distributed explaining how tourists may witness the Moki snake-dance, that weird ceremony by which the Pueblo Indian seeks to secure rain in his desert; and a similar public, and officially approved, ceremony has been observed in the heat-stricken State of Missouri.

Such epochs and episodes of regression as these must be taken into account in making up an estimate of scientific progress. They show us that the slow movement upward in the evolution of man which gives an algebraic sum of a few steps forward per century is not inconsistent with many steps backward. Or, to state the case in another way, the rate of scientific advance is to be measured not so much by the positions gained and held by individuals, as by the positions attained and realized by the masses of our race. The average position of civilized man now is probably

* Address of the retiring president of the American Association for the Advancement of Science, given at the Denver meeting on August 27, 1901.

below the mean of the positions attained by the naturalist, Huxley, and the statesman, Gladstone, or below the mean of the positions attained by the physicist, von Helmholtz, and his Holiness the Pope. When measured in this manner, the rate of progress in the past twenty centuries is not altogether flattering or encouraging to us, especially in view of the relapses similar to those which so long eclipsed geography and astronomy.

It must be confessed, therefore, when we look backward over the events of the past two thousand years, and when we consider the scientific contents of the mind of the average denizen of this planet, that it is not wholly rational to entertain millennial anticipations of progress in the immediate future. The fact that some of the prime discoveries of science have so recently appeared to many earnest thinkers to threaten the very foundations of society is one which should not be overlooked in these confident times of prosperity. And the equally important fact that entire innocence with respect to the elements of science and dense ignorance with respect to its methods, are not incompatible with justly esteemed eminence in the divine, the statesman, the jurist, and the man of letters, is one which should be reckoned with in making up any forecast. It may be seriously doubted, indeed, whether the progress of the individual is not essentially limited by the progress of the race.

But this obverse and darker side of the picture which confronts us from the past has its reverse and brighter side; and I am constrained to believe that the present status of science and the general enlightenment of humanity justify ardent hopefulness if not sanguine optimism with respect to the future of scientific achievement. The reasons for this hopefulness are numerous; some of them arising out of the commercial and political conditions of the world, and others arising out of the conditions of science itself.

Perhaps the most important of all these reasons is found in the general enlargement of ideas which has come, and is coming, with the extension of trade and commerce to the uttermost parts of the earth. We are no longer citizens of this or that country, simply. Whether we wish it or not we are citizens of the world, with increased opportunities and with increased duties. We may not approve—few men of science would approve, I think—that sort of "expansion" which works "benevolent assimilation" of inferior races by means of a Bible in one hand and a gun in the other; but nothing can help so much, it seems to me, to remove the stumbling blocks in the way of the progress of science as actual contact with the manners, the customs, the relations, and the resulting questions for thought, now thrust upon all civilized nations by the events of the day. That sort of competition which is the life of trade; that sort of rivalry which is the stimulus to national effort, and that sort of co-operation which is essential for mutual protection, all make for the cosmopolitan dissemination of scientific truth and for the appreciation of scientific investigation. I would not disparage the elevated aspirations and the noble efforts of the evangelists and humanists who seek to raise the lower elements to the plane of the higher elements of our race; but it is now plain as a matter of fact, however repulsive it may seem to some of our inherited opinions, that the railway, the steamship, the telegraph, and the daily press will do more to illumine the dark places of the earth than all the apostles of creeds and all the messengers of the gospel of "sweetness and light."

A question of profound significance growing out of the extension of commercial relations in our time is what may be called the question of international health. An outbreak of cholera in Hamburg; the prevalence of yellow fever in Havana, or an epidemic of bubonic plague in India, is no longer a matter of local import, as nations with which we are well acquainted have learned recently in an expensive manner. The management of this great international question calls for the application of the most advanced scientific knowledge and for the most intricate scientific investigation. Large sums of money must be devoted to this work, and many heroic lives will be lost, doubtless, in its execution; but it is now evident, as a mere matter of international political economy, that the cost of sound sanitation will be trifling in comparison with the cost of no sanitation; while further careful study of the natural history of diseases promises practical immunity from many of them at no distant day. International associations of all kinds must aid greatly, also, in the promotion of progress. Many such organizations have, indeed, already undertaken scientific projects with the highest success. Comparison and criticism of methods and results not only lead rapidly and effectively to improvements and advances, but they lead also to a whole-hearted recognition of good work which puts the fraternalism of men of science on a plane far above the level of the amenities of merely diplomatic life.

When we turn to the general status of science itself, there is seen to be equal justification for hopefulness founded on an abundance of favorable conditions. The methods of science may be said to have gained a footing of respectability in almost every department of thought, where, a half century ago, or even twenty years ago, their entry was either barred out or stoutly opposed. The "conflict between religion and science" —more precisely called the conflict between theology and science—which disturbed so many eminent though timid minds, including not a few men of science, a quarter of a century ago, has now been transferred almost wholly to the field of the theological contestants; and science may safely leave them to determine the issue, since it is evidently coming by means of scientific methods. The grave fears entertained a few decades ago by distinguished theologians and publicists as to the stability of the social fabric under the stress put upon it by the rising tide of scientific ideas, have not been realized. And, on the other hand, the grave doubts entertained by distinguished men of science a few decades ago as to the permeability and ready response of modern society to that influx of new ideas, have likewise not been realized. It is true that we still sometimes read of theological tests being applied to teachers of biology, and hear, occasionally, of an earnest search for a good Methodist or a good Presbyterian mathematician; but such cases may be left for settlement out of court by means of the arbitration of our sense of humor. It seems not unlikely, also, that there may persist, for a long time to come, a more or less guerrilla "warfare of science" with our friends, the dogmatists and humanists. Some consider this conflict to be, in the nature of things, irrepressible. But I think we may hope, if we may not confidently expect, that the collisions of the future will occur more manifestly than they have in the past in accordance with the law of the conservation of energy; so that the heat evolved may reappear as potential energy in the warmth of a kindly reasonableness on both sides, rather than suffer degradation to the level of cosmic frigidity.

Great questions, also, of education, of economic, industrial, and social conditions, and of legal and political relations are now demanding all the light which science can bring to bear upon them. Though tardily perceived, it is now admitted, generally, that science must not only participate in the development of these questions, but that it alone can point the way to the solutions of many of them. But there is no halting ground here. Science must likewise enter and explore the domain of manners and morals; and these, though already largely modified unconsciously, must now be modified consciously to a still greater extent by the advance of science. Only within quite recent times have we come to realize an approximation to the true meaning of the trite saying that the proper study of man is man. So long as the most favored individuals of his race, in accordance with the hypothesis of the first centuries, looked upon him as a fallen, if not doomed, resident of an abandoned reservation, there could be roused little enthusiasm with respect to his present condition; all thought was concentrated on his future prospects. How incomparably different does he appear to the anthropologist and psychologist at the beginning of the twentieth century! In the light of evolution he is seen to be a part of, and not apart from, the rest of the universe. The transcendent interest of this later view of man lies in the fact that he can not only investigate the other parts of the universe, but that he can, by means of the same methods, investigate himself.

I would be the last to look upon science as furnishing a speedy or complete panacea for the sins and sorrows of mankind; the destiny of our race is entangled in a cosmic process whose working is thus far only dimly outlined to us; but it is nevertheless clear that there are available to us immense opportunities for the betterment of man's estate. For example, to mention only one of the lines along which improvement is plainly practicable, what is to hinder an indefinite mitigation, if not a definite extinction, of the ravages of such dread diseases as consumption and typhoid fever? Or what, we may ask, is to hinder the application to New York, Philadelphia, and Chicago of as effective health regulations as those now applied to Havana? Nothing, apparently, except vested interests and general apathy. We read, not many years ago, that a city of about one million inhabitants had, during one year, more than six thousand cases of typhoid fever. The cost to the city of a single case may be estimated as not less, on the average, than one thousand dollars; making an aggregate cost to that city, for one year, of more than six millions of dollars. Such a waste of financial resources ought to appeal to vested interests and general apathy even if they cannot be moved by any higher motives. Thanks to the penetration of the enlightenment of our times, distinct advances have already been made in the line of effective domestic and public sanitation; but the good work accomplished is infinitesimal in comparison with that which can be, and ought to be, done. It is along this, and along allied lines of social and industrial economy, that we should look, I think, for the alleviation of the miseries of mankind. No amount of contemplation of the beatitudes, human or divine, will prevent men from drinking contaminated water or milk; and no fear of future punishments, which may be in the meantime atoned for, will much deter men from wasting their substance in riotous living. The moral certainty of speedy and inexorable earthly annihilation is alone adequate to bring man into conformity with the cosmic rules and regulations of the drama of life.

And finally we must reckon among the most important of the conditions favorable to the progress of science, the unexampled activity in our times of the scientific spirit as manifested in the work of all kinds of organizations from the semi-religious Chautauquan assemblies up to those technical societies whose programmes are Greek to all the world besides. Literature, linguistics, history, economics, law, and theology are now permeated by the scientific spirit if not animated by the scientific method. Curiously enough, also, the terminology, the figures of speech, and the points of view of science are now quite common in realms of thought hitherto held somewhat scornfully above the plane of materialistic phenomena. Tyndall's Belfast address, which, twenty-seven years ago, was generally anathematized, is now quoted with approval by some of the successors of those who bitterly denounced him and all his kind. Thus the mere lapse of time is working great changes and smoothing out grave differences of opinion in favor of the progress of science in all the neighboring provinces with which we have been able hitherto to maintain only rather strained diplomatic relations.

Still more immediately important to us are the evidences of progress manifested in recent years by this association and by its affiliated societies. Our parent organization, though a half century old, is still young as regards the extent in time of the functions it has undertaken to perform. It has accomplished a great work; but in the vigor and enthusiasm of its youth a far greater work is easily attainable. Just how these functions are to be developed, no man can foresee. We may learn, however, in this, as in other lines of research, by methods with which we are well acquainted, namely, by the methods of carefully planned and patiently executed observation and experiment. The field for energetic and painstaking effort is wider and more attractive than ever before. Science is now truly cosmopolitan; it can be limited by no close corporations; and no domain of scientific investigation can be advantageously fenced off, either in time or in place, from the rest. While every active worker of this or of any affiliated society is, in a sense, a specialist, there are occasions when he should unite with his colleagues for the promotion of the interests of science as a whole. The results of the specialists need to be popularized and to be disseminated among the people at large. The advance of knowledge to be effective with the masses of our race must be sustained on its merits by a popular verdict. To bring the diverse scientific activities of the American continent into harmony for common needs; to secure co-operation for common purposes; and to disseminate the results of scientific investigation among our fellowmen, are not less, but rather much more than in the past, the privilege and the duty of the American Association for the Advancement of Science.

Viewed, then, in its broader aspects, the progress of science is involved in the general progress of our race; and those who are interested in promoting the former should be equally earnest in securing the latter. However much we may be absorbed in the details of our specialties, when we stop to think of science in its entirety, we are led, in the last analysis, back to the problem of problems—the meaning of the universe. All men "gifted with the sad endowment of a contemplative mind" must recur again and again to this riddle of the centuries. We are, so to speak, whatever our prepossessions, all sailing in the same boat on an unknown sea for a destination at best not fully determined. Some there are who have, or think they have, the Pole Star always in sight. Others, though less confident of their bearings, are willing to assume nothing short of second place in the conduct of the ship. Others, still less confident of their bearings, are disposed to depend chiefly on their knowledge of the compass and on their skill in dead reckoning. We of the last class may not impugn the motives or doubt the sincerity of the first two classes. We would find it difficult, probably, to dispense with their company in so long a journey after becoming so well acquainted with them; for among them we may each recall not a few of those rarer individuals of the genus homo called angels on earth. But it must be said in all truth, to resume the figure, that they have neither improved much the means of transportation nor perfected much the art of navigation. They have been sufficiently occupied, perhaps, in allaying the fears of the timid and in restraining the follies of the mutinous. Other types of mind and other modes of thought have been essential to work out the improvements which separate the earlier from the later nautical equipments of men; such improvements, for example, as mark the distinction between the dug-out of our lately acknowledged relatives, the Moros and the Tagalogs, from the Atlantic liner of to-day. At any rate, we are confronted by the fact that man's conceptions of the universe have undergone slow but certain enlargement. His early anthropocentric and anthropomorphic views have been replaced, in so far as he has attained measurable advancement, by views that will bear the tests of astronomy and anthropology. He has learned, slowly and painfully, after repeated failures and many steps backward, to distinguish, in some regions of thought, the real and the permanent from the fanciful and fleeting phenomena of which he forms a part. His pursuit of knowledge, in so far as it has led him to certainty, has been chiefly a discipline of disillusionment. He has arrived at the truth not so much by the genius of direct discovery as by the laborious process of the elimination of error. Hence he who has learned wisdom from experience must look out on the problem of the universe at the beginning of the twentieth century with far less confidence in his ability to speedily solve it and with far less exaggerated notions of his own importance in the grand aggregate of Nature, than man entertained at the beginning of our era. But no devotee to science finds humiliation in this departure from the primitive concepts of humanity. On the contrary, he has learned that this apparent humiliation is the real source of enlightenment and encouragement; for notwithstanding the relative minuteness of the speck of cosmic dust on which we reside, and notwithstanding the relative incompetency of the mind to discover our exact relations to the rest of the universe, it has yet been possible to measure that minuteness and to determine that incompetency. These, in brief, are the elements of positive knowledge to which we have arrived through the long course of unconscious, or only half-conscious, experience of mankind. All lines of investigation converge toward and diverge from these elements. It is along such lines that progress has been attained in the past, and it is along the same lines that we may expect progress to proceed in the future.

EXPERIMENTS WITH SOUND SIGNALS.

TWENTY-FIVE years ago the Trinity House Corporation, with the advice and assistance of Prof. Tyndall, carried out some interesting experiments at the South Foreland, near Dover, in regard to the use of sound for signaling to the mariner, to warn him of his proximity to danger at times when fog or other kinds of thick weather prevented his seeing the land or seamarks by day or the guiding or warning lights at night. The scientific aspect of the question is fully given in the late editions of Tyndall on Sound, and the practical results obtained have been shown in the large increase in the number of fog signal stations around our coasts, and the adoption of certain instruments for producing sounds which had not previously been employed in this country. With the lapse of time and the growth of the coast fog signal system new knowledge has been gained and new developments have taken place, and it has become necessary to test by practical and comparative experiments the value of certain theoretical improvements which have from time to time been introduced, and to endeavor to determine some moot points which have arisen in connection with the general question. Accordingly a special committee of the Elder Brethren of Trinity House was appointed, the Deputy Master being chairman, with whom were associated Lord Rayleigh, as scientific adviser, and the engineers of the three lighthouse boards, to consider the present position of the subject and to carry out such experiments as they

might regard as necessary. St. Catherine's Point, in the Isle of Wight, was selected for the trials. Here there is a lighthouse with a powerful electric arc light, produced by steam power which also serves for compressing air into receivers for sounding a permanent fog signal.

At this station, says The London Times, the committee have now been carrying on their working during the past two or three weeks, observations being made at sea each day by members of the committee on board the Trinity yacht "Irene." One important question upon which the committee have been engaged is that of the relative merits of sirens as sound-producing instruments, as compared with reeds. It does not seem probable that the vibrations set up by means of a reed can possibly be so powerful as those produced by means of a siren, and it will be interesting to learn the results of the committee's observations on this point. The form of the trumpet or sound projector is also receiving considerable attention, Lord Rayleigh himself having certain theoretical views on the point which he desires to have practically tested. The relative merits of notes of different pitch, in regard to their capability of penetrating the atmosphere under unfavorable conditions, is another branch of the inquiry which is being followed up by the committee, and some useful information on this point may result from the experiments. The question of the most effective and economical utilization of power for operating sound signals is also receiving much consideration. It is obvious that there must be limitations in respect of the size of instruments and the development of power for working them. Other matters for inquiry and experimental test are questions connected with the best site for a land sound signal, regard being had to the nature of the coast line and the neighboring physical features; also how a sea area which is to be guarded can be most efficiently covered by the sound of the signal. The various forms of siren and reed vibrators have come into the trials, with a view of deciding which form, size and description of vibrator is best adapted for producing the sounds; and questions respecting pressure, air consumed, and length of blast, are also being dealt with. The investigations ought to yield some very interesting results, which it is hoped will in due course be published.

THE SCALE INSECT AND MITE ENEMIES OF CITRUS TREES.*

By C. L. MARLATT, First Assistant, Division of Entomology.†

INTRODUCTION.—Any consideration of the insect enemies of citrus plants must give large importance to the scale insects, or bark lice, which are not only very destructive on the orange and lemon and other citrus fruits, but are also the chief insect enemies of most other tropical and subtropical plants.

Scale insects are, as a rule, small and inconspicuous singly, but they multiply so rapidly that very soon an entire plant becomes infested—trunk, limbs, leaves, and fruit. The infested tree is rarely killed outright, but its growth may be almost completely checked and its fruit products rendered valueless.

Next in importance to the scale insects are the mite enemies of the orange and lemon, as represented by the mite which causes the rusting of the orange in Florida and the silvering of the lemon in California, and also the leaf mite, known from its coloring as the six-spotted mite of the orange. These mites, occurring along with the scale insects and being subject to similar remedies, may properly be considered in the same connection.

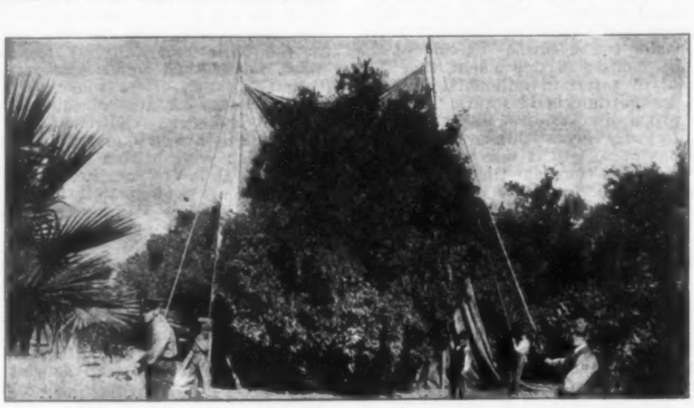


FIG. 1.—METHOD OF HOISTING TENT OVER ORANGE TREE.

Of very great importance to the Florida grower of citrus fruits is the so-called white fly, the latter not representing a scale insect in its ordinary acceptation, but in the practical features of life history and habits coming in the same category, and hence properly considered with the true scale insects.

There are a great many insect enemies of citrus plants other than the scale insects and mites, but, for this country, at least, these others, in the main, have no great economic importance, or are only very occasionally abundant enough to be especially destructive. In this category are the various leaf-feeding insects and some wood-boring species. At rare intervals some of these leaf-feeding species appear in numbers sufficient to defoliate trees more or less completely, or wood-borers may attack and hasten the death of frost-injured or otherwise weakened trees; but none of these insects calls for the constant attention and treatment which is necessary to prevent annual loss from scale insects.

Occurring about the orange and other citrus trees will be seen also a great many other insects which play a beneficial rôle, preying upon or parasitizing the scale insects living on these trees. It is very important to make the acquaintance of these beneficial species, more particularly to avoid, whenever possible, killing them in the warfare waged against the injurious ones.

SOME GENERAL CONSIDERATIONS BEARING ON CITRUS INSECTS.

Before taking up the consideration of the several species to be treated in this paper some general topics may be discussed, such as the influences which determine the destructiveness of these insects, the species characteristic of different regions, and the nature of the injury occasioned by them, natural enemies, remedies, and means of control.

INFLUENCE OF CULTIVATION, PRUNING, AND CLIMATE.

It is just as true in the case of the orange and lemon as it is with other plants that negligent cultivation and improper care, or any unfavorable conditions of climate which weaken the vitality and vigor of the tree, encourage the presence and multiplication of the insect enemies. On the other hand, there is something in the vigor of growth and conditions of the sap of a healthy tree, living under the best conditions, which is repellent to insect attack; and it will be almost invariably found that the unhealthy tree is the one first severely infested with scale insects or mites. This does not mean that vigorous, healthy trees will not be attacked, but on such trees insects seem to be less apt to multiply abundantly and effect the complete investment that is often noted in the case of a weak or improperly nourished plant. Therefore, as a means of protection against scale insects, a proper system of cultivation and pruning is highly important.

The value of pruning as a means of preventing scale-insect injury cannot be too strongly urged. Scale insects thrive best where they are protected from direct sunlight and free movement of the air, hence trees of dense growth, unpruned, are almost certain to have their centers, at least, scaly. A well-opened and pruned tree, in which free access is given to light and air, is much less apt to be badly attacked than a dense, thick-headed tree, the interior of which is entirely shaded and protected and the moisture held, thus furnishing the conditions most favorable for the well-being of scale insects. As a general proposition, therefore, light, air, and dryness are inimical to scale insects, and, conversely, shade and dense habit of growth, protecting from air currents and holding moisture, are favorable.

The truth of this is often exhibited in the citrus districts of the Pacific Coast. Very frequently the high temperature and dryness of the long summers, if allowed to have full action on well-opened and pruned trees, is as destructive to scale insects as would be a thorough treatment with an insecticide, in some cases killing the scales out almost completely. Similarly, scale insects are more apt to be abundant and troublesome in moist, warm regions than in regions with even higher temperature, but with a very much lower rate of humidity. In general, therefore, the citrus orchards in Florida, Jamaica, and the West Indies suffer more than do those in California. On the Pacific Coast, also, the orchards in moist ocean districts are much more apt to be infested than those farther inland with greater elevation and enjoying a lower degree of humidity, with occasional much higher summer temperatures. The black scale in California has,

FIG. 2.—REMOVING TENT BY HORSE POWER.

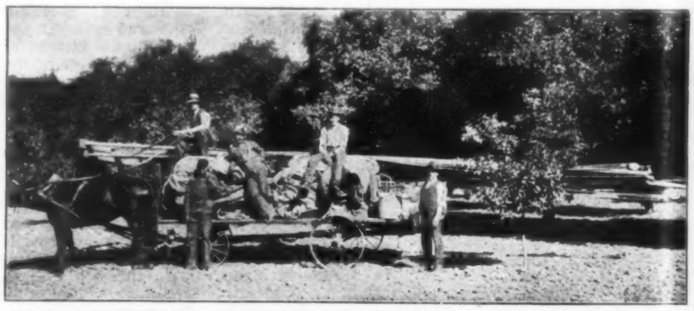


FIG. 3.—TENTS, TACKLE, AND CHEMICALS LOADED FOR TRANSPORTATION.

* No one can discuss the insect enemies of citrus plants without acknowledging indebtedness, as the writer now does most heartily, to the very comprehensive and valuable work on this subject prepared by the late H. G. Hubbard and published by this Department in 1885, and which for many years has been the chief authority on the subject covered. One is struck to-day, fifteen years after its publication, with the sound, practical ideas contained in it, particularly on the subject of the control of the scale and other insects treated. Mr. Hubbard was a successful orange grower in Florida, as well as a thoroughly trained scientific man, and one of the closest observers of insects this country has produced. The practical side of Mr. Hubbard's work is especially to be remembered also, because he was the deviser of the kerosene-soap emulsion, which, with allied washes, has for many years been the leading means of controlling scale insects. His work, entitled "Insects Affecting the Orange," but really covering the whole subject of citrus insects, having long been out of print, Mr. Hubbard was, just prior to his unfortunate illness and death, collecting data for a new edition, to be published by the Department of Agriculture. It will be a source of lasting regret that he was not able to accomplish this undertaking.

† Abridged from the Yearbook of the Department of Agriculture for 1900.

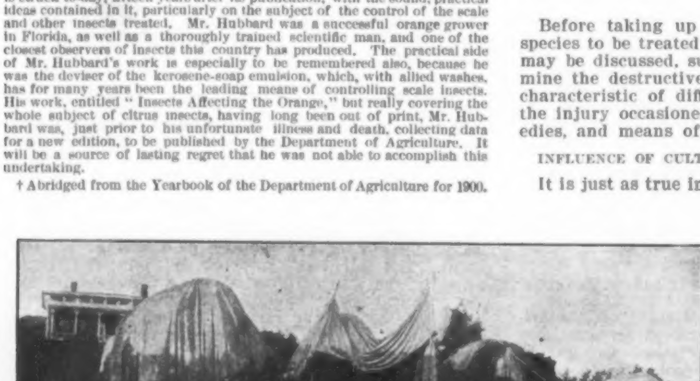


FIG. 4. A SAN DIEGO FUMIGATING OUTFIT.

FIG. 5.—THE BEAN-SPRAY PUMP IN OPERATION.

in places, been almost entirely exterminated by the temperature holding for several days above 100 deg. F., and a similar effect is noted with other species also.

PERIODICITY IN SCALE INSECTS.

With most insects injurious to cultivated plants a periodicity is noted in their occurrence in injurious numbers. In the case of subtropical species, like the scale insects affecting citrus plants, this periodicity is not always as marked as it is with insects affecting deciduous plants and field crops in temperate latitudes. While it is true that scale insects have always occurred more or less on citrus trees in the Old World and wherever these plants are cultivated, investigation will undoubtedly show that there have been more or less well-marked periods of destructive abundance separated by periods of comparative scarcity. In illustration of this may be noted the epidemic referred to by Hubbard as prevailing throughout the entire orange, lemon, and olive districts along the shores of the Mediterranean from Italy to Spain during the first decade of the present century, to the consternation of the inhabitants, who were dependent upon these fruits. This unusual scale epidemic subsided, however, and very largely of itself, efficient remedies at that date being practically unknown.

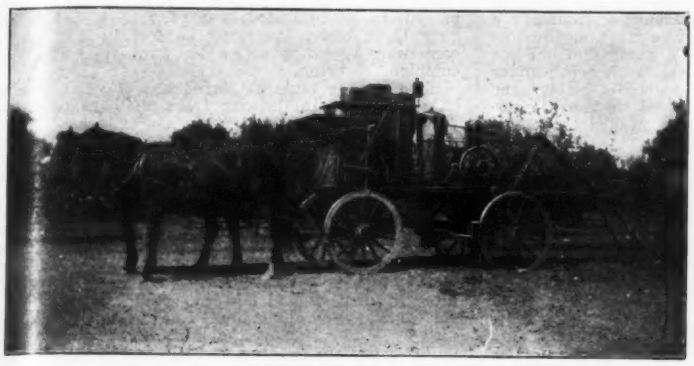


FIG. 6.—GASOLINE-SPRAYING OUTFIT, CHULAVISTA, CAL.

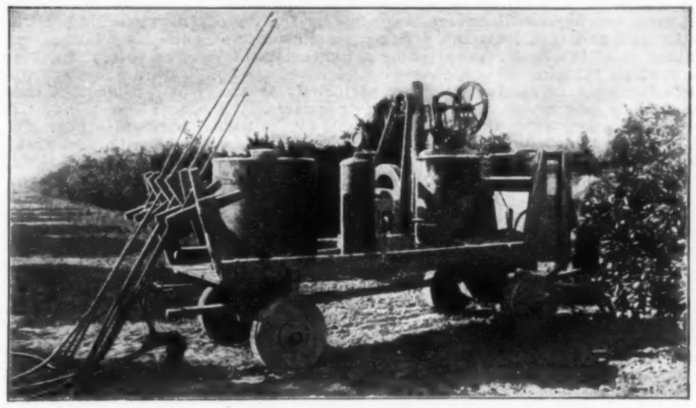


FIG. 7.—STEAM SPRAYER, USED AT RIVERSIDE, CAL.

In the same way in this country, scale infestation varies considerably from year to year. The fluted scale, in California, increased enormously during the first ten or fifteen years and threatened the very existence of the citrus cultures. Thanks, however, to the Australian ladybird, and, doubtless also, to the fact that many native predaceous and parasitic insects became acquainted with it, it is no longer feared in California. The long scale in Florida, also, was much more injurious in the first years of its activity than it has been since. In 1896 the black scale was very abundant and destructive in the orange districts about Riverside. Partly owing to adverse climatic conditions and partly owing also to natural enemies, this insect has almost disappeared from this district, which is now one of the least affected by scale insects.

These facts are merely cited to give the citrus grower whatever encouragement they may offer, but not in the least with the idea of belittling for an instant the need of remedial operations for the prompt and immediate control of scale insects whenever and wherever they appear. While, therefore, we may reasonably anticipate the necessity of yearly control of one sort or another, we may yet hope that any unusual abundance, perhaps exceeding our efforts at control, may not necessarily represent a permanent, but rather a temporary condition.

SPECIES CHARACTERISTIC OF FLORIDA AND THE PACIFIC COAST, RESPECTIVELY.

The culture of citrus fruits in this country, limited as it is in the main to two widely separated localities —Florida and the Gulf region on the one hand, and the Pacific Coast region on the other—has presented in the past, perhaps more than at present, a distinct variation for the two regions in the character of the scale and other insect enemies. This is very naturally to be expected in view of the difference in climatic conditions exhibited by these two regions, one having practically a desert climate with scant rains in winter, depending almost entirely on irrigation, and the other a very moist climate with frequent rainfalls and a very high rate of humidity.

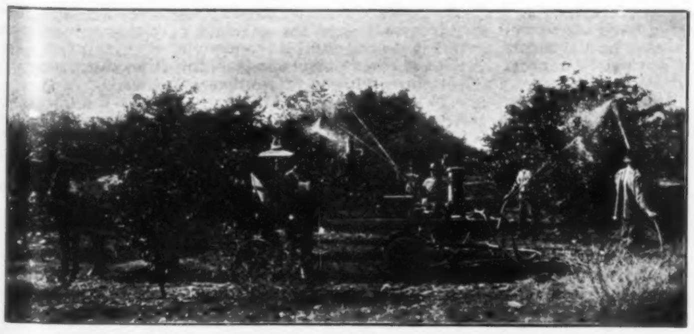


FIG. 8.—GASOLINE SPRAYER, CROCKER-SPERRY LEMON GROVE, SANTA BARBARA, CAL.

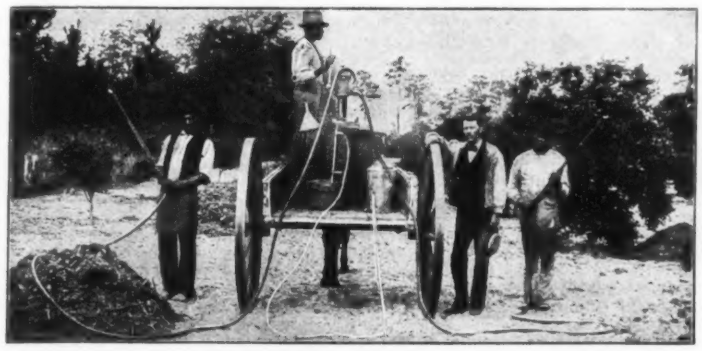


FIG. 9.—OLD-TIME FLORIDA HAND-SPRAYING OUTFIT.

Until recent years, the scale insect enemies of distinct importance in California have been limited to very few species, notably the black scale and the California red scale, together with the so-called "yellow" variety of the latter, and, prior to the introduction of the Australian ladybird, the fluted scale.

In Florida and the Gulf districts the species of greatest importance are the long and purple scales, the Florida red scale, the chaff scale, and the white fly, the latter, as already explained, closely resembling but not representing a true scale insect. The rust mite and the six-spotted mite, long known in Florida only, have in recent years been carried to California, and are slowly invading the southern citrus districts of that state. The other insect enemies of the orange and lemon, also formerly characteristic of one or the other of these two regions, are rapidly becoming common to both, although in point of injurious abundance the distinction between the two regions still, in the main, holds. The black scale occurs in Florida but is not troublesome at all, and the California red scale has not, apparently, been able to establish itself in Florida, but is very troublesome on some of the West Indian islands. The fluted scale, introduced in one locality in Florida in 1893, has spread locally very slowly, not appearing elsewhere so far as known. On the other hand, the distinctive Florida scales have all been taken to California and are slowly establishing themselves, but so far have not assumed the injurious rôle in California which they play in Florida.

NATURE OF THE INJURY OCCASIONED BY SCALE INSECTS.

The damage occasioned by scale insects is of two kinds. The first and principal injury is the extraction of the juices of the plant, the scale insect in its relation to its food plant being a mere pumping machine, which is continually absorbing the sap from its host. In a general way the scale insect is a mere sack with sucking mouth parts, the latter consisting of a long, slender proboscis, or beak, which is thrust deeply into whatever portion of the plant the insect may be resting upon—bark, leaf, or fruit. While the amount of sap extracted by a single insect is very small, when multiplied by millions it greatly depletes the juices of the plant. Very often the amount taken up by the scale insect is greatly in excess of its own needs, and is excreted in the form of the so-called "honeydew," which accumulates in drops and spreads out over the bark or leaf in the form of a sticky liquid. This liquid attracts ants in great numbers, which very often gives rise to the belief that the ants are depredating on the plant, instead of, as the fact is, merely being attracted by the honeydew, which they are actively collecting.

The second form of injury caused by scale insects results largely from this honeydew excretion, which not only spreads over the leaves and fruit and prevents the normal respiration of the leaves and the development of the plant, but a black fungus develops in the sweetish liquid and ultimately thickly covers the leaves, twigs, and fruit, still further stifling the plant and reducing the marketable value of its products. It very often happens, therefore, that the grower is more anxious to avoid the presence of this fungus which follows the scale insect attack than the injury by the scale insect itself.

Associated with the damage due to the absorption of the juices of the plant by the scale insect is very often a poisoning of the plant itself caused by the irritation excited by the beak of the insect or by some liquid injected by the beak. In the case of the orange, lemon, and other citrus fruits, this injury is not so apparent as it is with the scale insects attacking deciduous plants, but it undoubtedly occurs with citrus plants, to some extent, at least.

Another reason for the extreme injury wrought by the scale insects arises from the fact that they are active the whole year round in climates where citrus trees can be grown. Their greatest activity and most rapid breeding period is during the summer months, and especially from May to August, or with very little check until October or November. In the winter season, or rainy season, they are more dormant and, while breeding continues to a greater or less extent, it is at a very much lessened rate.

THE NATURAL ENEMIES OF THE CITRUS SCALE INSECTS.

Attention has already been drawn to the great desirability of protecting and encouraging the natural enemies of scale insects. The natural predaceous enemies of scale insects of greatest importance are various species of ladybirds, as illustrated by the Australian ladybirds, imported to control the fluted and black scales, and a great many native species, which are very effective agents in the control of these and other scale insects. The work of ladybirds is especially important against the young of the armored scale and against the softer and freely-moving scale insects which secrete no protective covering. Whenever, therefore, ladybirds of any species are found to be abundant on any scale-covered tree, they may be safely recognized as friends and working in the interest of the grower. If they are very abundant, indeed, it may be even unwise to fumigate or spray. The black scale has been completely controlled on certain ranches in California by its imported ladybird enemy, and this control has been brought about by the entire cessation of all insecticide operations. Most of our ladybirds, however, will probably stand a spraying without being killed, and, as a rule, it is hardly worth while to take the chance of loss to the fruit while waiting for the ladybird enemies to do their work. The experience, however, on the Cooper ranch and at other localities in California has certainly demonstrated the advantage of giving the ladybird enemies a fair chance. Those interested in this subject should consult the article on "Insect Control in California," by the writer, published in the Yearbook of the Department of Agriculture for 1896, and also the portions of the present paper relating to the black and the fluted scale.

The other important class of enemies of scale insects are the hymenopterous parasites. The recognition of these friends is not so easy as that of the ladybirds, and, as a rule, they will probably escape detection. If one finds that the black scale or the armored scales are pierced with minute round holes, it is a safe indication that they have been parasitized, and that the parasites have escaped and are multiplying in the younger scale insects on the trees; and here again, if the parasitism is found to be general, it may be inadvisable to spray or fumigate.

The other natural enemies of scale insects are not so important as those mentioned; still they are of service, and should be recognized. These include the larvæ of the lace-winged flies (*Chrysopa* spp.), which feed on the young of both the armored and the unarmored scales. There are also a few dipterous, or fly, parasites of scale insects, and the larvæ of several species of Lepidoptera are carnivorous and feed on the larger species of scale insects, such as the Lecaniums and wax scales. The latter are sometimes abundant enough to afford a very considerable check on the multiplication of the species of scale insects attacked. The various species of ants which are usually abundantly associated with scale insects on trees, and which are very often supposed to be preying upon the scale insects, have no beneficial action in this direction whatever. They are attracted to the trees, as already noted, by the honeydew secreted by the scale insects, and their rôle, if worth considering at all, is an unfriendly one, since they are a means of conveying the young scales which may attach to their legs or bodies from one plant to another.

A most desirable outcome would be to secure a complete and practical control of scale insects by their

natural enemies, and the immense benefit which would accrue to the people of this country if it were possible to control all scale insects as the fluted scale has been controlled, will be at once apparent. The conditions, however, in the case of the fluted scale were exceptional, and have not been duplicated in the case of any other scale insect; even in the case of the black scale the control has been complete only in a few instances, although its imported ladybird enemy has been distributed in enormous numbers throughout southern California. Spraying and fumigation, therefore, must be relied upon for some time to come, or at least until the natural enemies have been more fully studied, and better means of successfully colonizing them devised. Climatic conditions also affect the activity of these natural enemies to such an extent that the same results can never be counted on in different localities.

In considering the agency of control afforded by the natural enemies of scale insects, the fact must not be lost sight of that these predaceous and parasitic enemies are dependent on the scale insects for their existence, and that therefore a fairly complete extermination of the host insects means a like extermination of its parasitic or predaceous enemies. There is, therefore, a natural alternation or periodicity in the abundance of the scale insect and its parasites. An almost complete extermination of the scale by the parasite means, ultimately, a very great scarcity of the parasite, which gives the scale insect a chance to slowly reappear in increasing numbers. This is followed again by the recurrence of the parasite in great numbers, and the host insect in turn disappears once more. If reliance be made solely on the predaceous and parasitic insects, therefore, this periodicity in the occurrence of the scale must be counted on. Theoretically, it is true that such recurrences of the scale enemy may be controlled to a certain extent by an introduction of the parasitic insect the moment the scale has begun to be abundant, in this manner assisting the early multiplication of the natural enemy. This is practically accomplished now in the case of the black scale on the Cooper ranch and a few other localities in California, and in the case of the fluted scale in California, South Africa, and Portugal. To succeed in such efforts, it is necessary to have an efficient parasite or predaceous insect, and also regular breeding places where these may be secured when wanted. These conditions may be naturally supplied when a whole district, such as California, is under constant observation, and the localities where the parasite and scale are occurring together are known. From such points the ladybirds or other enemies may be collected and shipped to the districts needing them. By such constant transportation and recolonization the parasite is kept from nearly complete extermination, and is available when needed.

THE DIRECT MEANS OF CONTROLLING CITRUS SCALE INSECTS.

Scale insect enemies of citrus trees are controlled in two ways: Either by spraying the infested plants with some liquid insecticide or by subjecting them to the fumes of hydrocyanic-acid gas, commonly designated as "gassing." Each of these methods of control has its place.

The gassing method (illustrated in Figs. 1, 2, 3, and 4) is undoubtedly the most effective means known of destroying scale insects. It has been in general use in California for fifteen years, and to a less extent elsewhere on citrus trees, and the methods are now thoroughly perfected and highly satisfactory. Gassing should undoubtedly be employed wherever the expense of the treatment, which is the one objection to it, is not an object as measured by the value of crop protected. For most species of scale insects, one good gassing is worth as much or more than two or three sprayings, and when done at the right season and properly it very frequently will almost, if not quite, exterminate the scale insects from the treated trees, giving them comparative immunity often for two or more years. This is especially true of the black scale and the California red scale. The use of hydrocyanic-acid gas is, therefore, strongly urged wherever the conditions warrant it. Gassing is especially desirable for trees that have a dense habit of growth, such as the orange, which develops a large, thick head, the spraying of which thoroughly and completely is almost an impossibility, especially after the trees have attained any size. The more straggling growth of the lemon makes gassing less necessary, notably where the open system of pruning is adopted.

It may often happen that gassing is impracticable or that the expense of the treatment, in view of the conditions, is not warranted. This last may be the case where the rancher has not sufficient capital to keep up the heavy outlay necessitated by the gassing of young stock which yields no revenue. Gassing is also difficult and less desirable where, as for the lemon in southern California, the low, open-center pruning is adopted, the trees under this system of pruning often having an expanse of 20 feet, with a height of scarcely more than 6 feet. This open system of pruning and more straggling form of growth, on the other hand, makes the lemon easier to treat with liquid sprays, and under such conditions spraying will probably prove more practicable and profitable than gassing, particularly in view of the comparatively inconsiderable cost of the former. Nevertheless, where lemon trees are of a form and size to admit of it, and the crop warrants the expense, gassing is always to be recommended for the two scale insects mentioned, and others for which it is equally effective. With the orange, except for young trees, spraying is hardly to be advised, especially in view of the general custom of pruning this tree but little, if at all, and allowing it to form oval dense tops.

The expense of spraying is not heavy, compared with gassing. In most of the citrus districts of California where spraying is practised to any extent there are individuals who make a business of treating orchards at a charge of a cent a gallon for the liquid applied, or about double when they furnish as well as apply the insecticide. This work is now commonly done with a power apparatus, and usually in a fairly satisfactory manner. (See Figs. 5, 6, 7, and 8.) The difficulty in depending on the public sprayer is that it is very often not available when much needed. For a large ranch, the possession of a power spraying outfit will probably prove economical in the long run, and anyone contemplating securing one is referred to the general article on such machines, by Dr. L. O. Howard, in the Yearbook of the Department of Agriculture for 1896.

For the small rancher, having from 10 to 30 acres of orchard, it is not necessary to go to the expense of a steam or a gasoline spraying apparatus. There are a great many excellent force pumps on the market which may be easily equipped with suitable hose and nozzles, and which will do the work of spraying very satisfactorily. A hand force pump with suitable connections, which may be equipped for work at a cost of from $25 to $30, will meet all requirements. Another effective hand outfit employed on the ranch of Mr. J. E. Thoustrup, at La Mesa, Cal., is illustrated in Fig. 5. The pump for such an outfit should be capable of easily producing a pressure of 100 pounds, which will supply four cyclone nozzles attached to two lines of hose. With such an apparatus, the writer was able to apply easily 50 gallons an hour, or 500 gallons a day, working with three men, and this covers also the time lost in mixing the insecticide and refilling. The cost of applying the same amount of liquid by a contract sprayer would represent as much as the cost of the labor of three men, one to pump and one for each line of hose; furthermore, the work being under personal supervision, will be undoubtedly better done and with less waste of material, and, of more importance still, at the time when most needed and when the greatest advantage will result.

Trees under seven years old will probably not require more than a gallon of spray—ranging from half a gallon to a gallon. An orchard of 10 acres of trees, planted on the hexagonal system, 24 feet apart, gives 86 trees to the acre, or 860 trees for 10 acres, and would represent a cost of spraying of about $8 for the spray and as much more for the labor. In other words, spraying with the insecticides commonly employed, such as "distillate," kerosene emulsion, and resin wash, may be safely estimated to cost about 2 cents a gallon for the amount of liquid used, or not exceeding 2 cents per individual tree under seven years of age. On the other hand gassing a tree seven years of age will cost from 12 to 15 cents per tree, or the equivalent of from five to seven sprayings. The advantage, therefore, of spraying, for the small owner, and for trees especially suited by form of growth or pruning to such treatment, is evident.

Successful as gassing is, it is not effective in the same degree against all the scale insect enemies of citrus plants. For example, some of the armored scales require two or three gassings to effect anything like extermination, rendering the treatment almost prohibitive. Gassing is also not effective against the rust mite. It is especially valuable against the black scale and the red scale of California. With such of the armored scales as are oviparous, or deposit beneath the old scales eggs which undergo a certain amount of incubation before hatching, gassing is not always effective. Under such circumstances it will only kill the young and developing insects, but often many of the eggs and, in some instances, even the old females are not destroyed, rendering it necessary to make additional treatments after a sufficient period has elapsed to allow all the eggs to hatch and the young to escape. For all these insects, spraying is, as a rule, more desirable than gassing, because the expense of treatment is much less and there is more likelihood of its being repeated with sufficient frequency to accomplish the desired result.

The gas treatment for the black scale, however, is often most striking in its results. Applied late in October or early in November after all the young scales have hatched, as noted by the writer, badly infested orchards have been completely cleaned in a single gassing. The black scale is especially adapted to control by gassing on account of its being, in the main, single brooded, practically all of the scales being in a young or partly grown condition at the period designated. Gassing in midsummer for this insect will be ineffective, because a large percentage of the old females at this period cover and protect unhatched eggs.

METHOD OF GASSING TREES.

The details of the use of hydrocyanic-acid gas as a fumigant for scale insects on growing trees are so well known in the citrus districts, at least in California, that a minute description of the process is unnecessary. Briefly, the treatment consists in inclosing a tree at night with a tent and filling the latter with the poisonous fumes generated by treating refined potassium cyanide (98 per cent strength) with commercial sulphuric acid (66 per cent) and water.

The proportions of the chemicals as now employed in California are considerably in excess of the amounts recommended a few years since, or as recently as 1898. The gas treatment was first chiefly used against the black scale, and at a season of the year when these scales were all in a young stage and easily killed. The effort is now made not only to kill the black scale, but also the red scale, and to do more effective work even than formerly with both of these scale insects.

A table prepared indicates for the smaller trees twice as much cyanide and acid as was formerly advised, and for the larger trees three times the former amounts. Another table indicates a considerable increase over the first, and three or four times as much of the chemicals as was generally recommended as late as 1898. The greater expense entailed by this larger quantity of chemicals is offset by the more effective results and the consequently longer intervals between treatments. Mr. Havens suggests, in connection with his table, that for small trees ordinary earthenware vessels may be used to generate the gas. For large trees requiring heavy doses tall wooden pails have proved more practicable, two generators being employed for the very largest trees. It is important that the water be put in the vessel first, and then the acid, and lastly the cyanide. If the water and cyanide are put in the vessel first and the acid poured in afterward, there is danger of an explosion, which will scatter the acid and burn the tents and the operator. In the spring, when the trees are tender with new growth, and in early fall, when the oranges are nearly grown and the skins are liable to be easily marred, and also with young trees, it is advisable to add one-third more water than ordinarily used, or the cyanide in larger lumps. This causes the gas to generate more slowly and with less heat, and if the tents are left over the trees a third longer the effectiveness of the treatment will not be lessened.

The extremely dangerous nature of the gas must be constantly borne in mind and the greatest caution should be taken to avoid inhaling it. The treatment is made at night, and the person handling the chemicals should always have an attendant with a lantern to hold up the tent and enable the cyanide to be quickly dropped into the generator and to facilitate the prompt exit of the operator.

As with spraying, the gassing is often done (and this is very desirable also) by individuals or companies who make a regular business of it, charging a fixed rate per tree, depending on size—from 10 cents to a dollar or more. Much of this work is also done under the direct supervision of the county horticultural commissioners, which gives a greater assurance of efficiency.

Practically the only tent now used is the so-called "sheet tent," which is drawn up over the tree by means of pulleys, as indicated in Figs. 1, 2, 3, and 4. For very large trees, averaging 30 feet in height, it is sometimes necessary to employ two sheets to effect a complete covering.

Some of the tents employed are of great size, the one illustrated in the cut, from photographs secured for us by Mr. Havens, having a diameter of 76 feet. As described by Mr. Havens, it is constructed of a central piece 50 feet square, of 10-ounce army duck. Four triangular side-pieces, or flaps, of 8-ounce duck, 10 feet wide in the middle, are strongly sewed to each side of the central sheet, forming an octagonal sheet 70 feet in diameter. About the whole sheet is then sewed a strip of 6-ounce duck 1 yard wide. The tent is handled by means of ropes and pulleys. A 1½-inch manila rope is sewed about the border of the central piece in an octagonal pattern. Rings are attached to this rope at each of the eight corners thus formed, and also on either side of the tent. To these rings the pulley ropes are fastened and the tent is elevated over the tree and handled as indicated in the cuts.

The treatment is made altogether at night, although it would be possible to treat trees also on a very dark or cloudy day. In California, however, at the time the gas treatment is made, such days are infrequent. About 50 trees of the largest size, 30 feet high or thereabouts, can be treated in a night with an equipment of twelve or fifteen tents. With smaller trees, the number which can be treated in a single night is very considerable, it being possible to gas from 300 to 500 trees averaging 10 feet in height, in eleven or twelve hours, employing thirty-five to forty ring tents.

SPRAYS FOR CITRUS TREES.

The oily washes are by far the best for use on citrus trees against scale insects. The attempt has been made in various places to substitute lye washes for the old standard kerosene washes, but the effect has, as a rule, been disastrous. Lye applied to a tree strong enough to kill scale insects, as demonstrated by Hubbard fifteen years ago, is very destructive to the tender growth of the tree, and the damage from the wash is often greater than that occasioned by the insects themselves. The kerosene and resin washes formerly used in California have now given place, to a considerable extent, to a modification of kerosene emulsion known as "distillate." As now employed, the washes in the order of their popularity are: (1) Distillate; (2) resin wash; (3) kerosene emulsion. The probability is that distillate will ultimately supplant the other two on account of its equal, if not greater, efficiency and smaller cost.

Distillate.—This wash was originated by Mr. F. Kahles, the very efficient superintendent of Las Fuentes Rancho, belonging to Messrs. Crocker & Sperry, Santa Barbara, Cal. It has been recommended by Professor Lelong, of the State Board of Horticulture, and has found very general use in the Santa Barbara region, and also in the lemon districts adjacent to San Diego, as well as in other citrus districts in California. It is substantially an emulsion of crude kerosene, made in the same way as kerosene emulsion, except that a greater amount of soap and only half as much oil are used. Its cheapness arises from the fact that it requires only half the quantity of oil, and in spite of this lessening of oil it seems to be, if anything, stronger than kerosene emulsion, judging from the writer's experiences with it in southern California.

It is termed distillate spray, because the oil used is a crude distillate of the heavy California petroleum. The product used for spraying purposes should have a gravity of about 28 deg. Baumé, and is the crude oil minus the lighter oils, or what distills over a temperature between 250 deg. and 350 deg. C. It is similar to the lubricating oils in characteristics.

The emulsion or, as it is generally known, "cream," is prepared as follows: Five gallons, "28 deg. gravity," untreated distillate; 5 gallons water, boiling; 1½ pound whale-oil soap. The soap is dissolved in the hot water, the distillate added, and the whole thoroughly emulsified by means of a power pump until a rather heavy, yellowish, creamy emulsion is produced. This emulsion is very similar to the product obtained with refined kerosene, following the old kerosene emulsion formula, except that it is slightly darker in color. For use on citrus trees it is diluted with from 12 to 15 parts of water. The former dilution is the greatest strength advisable, and is for the lemon. It should be diluted with 15 parts of water for applications to the orange, the lemon standing readily the stronger mixture. The "distillate cream" is prepared and sold by oil companies and private individuals at from 10 to 12 cents a gallon, making the dilute mixture, as applied to the trees, cost in the neighborhood of a cent a gallon. The writer found kerosene emulsion, made by the same companies, to cost from 12 to 15 cents a gallon, the item of cost, therefore, being in favor of the distillate. Either of these emulsions can be made at home at a considerable saving over these prices if one is provided with the necessary equipment. In using these oil emulsions, it is advisable to first break the water by the addition of a little lye, a fourth of a pound of lye being ample for 50 gallons of water.

Kerosene Emulsion.—This wash, made according to

the old formula (kerosene, 2 gallons; whale-oil soap, one-half pound; water, 1 gallon), is prepared in the same way as the distillate and used at the same strength. It does no harm to use double the quantity of soap indicated, securing in this manner a rather more stable emulsion and one not so easily affected by hard water. It is always advisable, however, to break the water with lye, as indicated above. This emulsion, while perhaps somewhat less efficient than the distillate emulsion, differs from the latter in effectiveness very slightly at the most, and is always available where the latter may not be in reach. It may be prepared on a small scale with an ordinary hand pump, but is best prepared in large quantities with a gasoline or steam-power pump to mix and emulsify it after the soap has been dissolved in the water by boiling.

The Resin Wash.—This wash is especially valuable against the California red scale. It may be also used against any other scale insect, including the black scale and the various armored scales affecting citrus trees. The wash is made as follows: Resin, 20 pounds; caustic soda (78 per cent), 5 pounds; fish oil, 2½ pints; water to make 100 gallons. Ordinary commercial resin is used, and the caustic soda is that put up for soap establishments in 200-pound drums. Smaller quantities may be obtained at soap factories, or the granulated caustic soda may be used, 3½ pounds of the latter being the equivalent of 5 pounds of the former. Place these substances with the oil in a kettle with water to cover them to a depth of 3 or 4 inches. Boil about two hours, making occasional additions of water, or until the compound resembles very strong, black coffee. Dilute to three times the final bulk with hot water, or with cold water added slowly over the fire, making a stock mixture to be diluted to the full amount as used. When sprayed, the mixture should be perfectly fluid, without sediment, and should any appear the stock mixture should be reheated; in fact, the wash is preferably applied hot. This wash is much more difficult to prepare than the kerosene emulsions referred to above, and, while it is an excellent wash, it probably will be ultimately largely supplanted by the emulsions of kerosene.

HOW ARCTIC ANIMALS TURN WHITE.

By R. Lydekker.

Although I have not the details of any one particular case before me, so many instances are chronicled in which the hair of human beings, under the influence of strong mental emotion due to terror or grief, has become suddenly blanched within a single night or some such period of time, that the occasional occurrence of such a phenomenon must apparently be accepted as a fact. Such a change is, of course, due to the bleaching of the pigment with which the hair is colored, although we need not stop to inquire by what particular means this bleaching is accomplished; all that concerns us on the present occasion being to know that the hair in man may turn white in this manner under abnormal circumstances. And there appears to be evidence that under equally abnormal conditions a similar change may take place suddenly in the hair of the lower animals. This is exemplified by the well-known experiment made considerably more than half a century ago by Sir John Ross on an Arctic lemming—a small mouse-like rodent, which habitually turns white in winter, although dark-colored in summer. In this instance the little animal was kept in a comparatively warm room till winter was well advanced, when it was suddenly exposed to a temperature of 30 deg. below zero; a continued exposure to this and a still more intense degree of cold eventually resulting in its death, which took place within three weeks of the commencement of the experiment. In consequence of the conditions under which it had been kept, this lemming was still brown in midwinter, when it ought to have been white. As a result of its first night's exposure, the fur on the cheeks and a patch on each shoulder became completely white, and by the end of the first week the whole coat had turned white. On examination it was found that only the tips of some of the hairs had become blanched, and that these white-tipped hairs were longer than the rest of the coat, apparently owing to a sudden growth on their part in the course of the experiment. By clipping these long white-tipped hairs the animal was restored to its original brown condition.

Nothing is said with regard to any change of coat on the part of this lemming previous to the experiment, but it is probable that none occurred. It seems, however, to be clearly demonstrated that the tips of the hairs lost their color by bleaching, induced by sudden exposure to the intense cold, and that the hairs thus blanched increased considerably in length in a very short period.

In spite of the very obvious fact that these changes occurred under extremely abnormal circumstances, it has been argued that Arctic mammals which turn white in winter do so normally by a similar blanching of the hair of the summer coat, and that the greater length of the winter, as compared with the summer dress of such white animals, is due to a lengthening of the individual hairs of the former.* Moreover, it has been inferred that the color-change is directly under the control of the animals themselves. Quite apart from many other considerations, one weak point in this argument is that the hairs in the subject of the experiment were white only at their tips. It was doubtless assumed that had the experiment been continued over a longer period, the white would have gradually extended downward till the whole hair became blanched. But had this been the normal way in which the change from a dark to a white coat is brought about, it is obvious that animals ought frequently to be captured in which the coat is in the same condition as that of the lemming. So far, however, as I am aware, no such condition has ever been described.

Moreover, it is perfectly well known that, apart from those which turn white in winter, a large number of animals have a winter coat differing markedly in color, as well as in length, from the summer dress. The roebuck, for instance, is of a brilliant foxy red in summer, while in winter it is gray fawn with a large patch of pure white on the buttocks. And it is quite clear that the change from red to gray, and the development of the white rump-patch, is due to the shedding of the short summer coat and its replacement by the longer winter dress. Obviously, therefore, it is natural to expect that a similar change of coat takes place in the case of mammals which turn white in winter.

That the change in spring from a white to a dark dress is due to a shedding of the fur seems to be admitted on all hands, for it would be obviously quite impossible for long hairs to become short, or for white ones to turn brown. And even in animals which do not alter their color in any marked degree according to season, the spring change of coat is sufficiently obvious. For the winter coat, owing to the long time it is worn and the inclemency of the season when it is in use, becomes much faded and worn by the time spring comes, and the contrast between it and the fresh and brilliant summer coat is very striking indeed. On the other hand, the summer coat is only worn for a comparatively short season, and that at a time of year when it does not become much damaged by the effects of the weather. Consequently no marked change is noticeable as the long winter hairs grow up through it; and it has accordingly become a common article of belief that, whether there is a change of color or not, the long winter coat is produced by a lengthening of the summer dress.

Apart from the evidence of animals like the roebuck and many other deer as to the existence of an autumn change of coat, as deduced from a difference in color, the fact of such a shedding of the fur is demonstrated by the circumstance that in many species—as, for instance, the mountain hare—the individual hairs themselves, as seen under a microscope, differ appreciably in caliber at the two opposite seasons of the year. In that species, for example, the hairs of the winter coat are of a much finer character than are those forming the short dress of summer, which are comparatively coarse and thick. Moreover, in spite of the natural tendency to believe in blanching on account of the aforesaid abnormal instances of turning white in a single night, there is abundant evidence to show that even in human hair the change from dark to white as age advances is brought about by the replacement of dark hairs by white ones, and not by the bleaching of the former. In this case, however, the change, instead of being seasonal and sudden, is gradual and due to age. If the change was due to blanching, we should, of course, find some hairs which were partially white and partially brown (or black, as the case may be). And here it may be remarked that if such partially blanched hairs were met with, we should naturally expect to find that it would be the basal half which was white, and the terminal half which retained its natural coloring. In other words, precisely the reverse of the condition obtaining in Sir John Ross' lemming; thereby affording further presumptive evidence as to the abnormal condition of the change in that animal.

As a matter of fact, however, those of us who have reached an age when silver hairs have begun to make their appearance among the brown can easily satisfy themselves that such hairs are white throughout their entire length, and that a hair half-white and half-brown is quite unknown. From this we infer that the change from brown to white takes place in human beings by the gradual shedding of the dark hairs and their replacement by new ones from which pigment is entirely absent. So that normally there is no such thing as bleaching of individual hairs. The change is, indeed, precisely similar to that which takes place at the approach of winter in mammals that habitually turn white at that season, with the exception that, as a general rule, it is extremely slow and gradual, instead of being comparatively rapid, and also that the white hairs differ from their dark predecessors solely by the absence of coloring matter. Unfortunately, there is no subsequent replacement of the white hairs by dark ones.

The fact that the change from brown to white in the mountain hare (*Lepus timidus*) is really due to a change of coat and not to bleaching was known at a very early period to the English naturalist, Pennant; and the existence of this coat-change was likewise recognized by Macgillivray. It was not, however, till Dr. J. A. Allen, in a paper on the color-change in the North American variable hare, published in the Bulletin of the American Museum of Natural History for 1894, demonstrated by actual experiment the truth of Pennant's statement that the fact of the complete autumnal change of the coat in animals that turn white in winter was generally recognized by naturalists. So far as the spring change from the white to the brown dress is concerned, his conclusions are fully confirmed by Mr. G. E. H. Barrett-Hamilton, who communicated some interesting notes on the change in the European mountain or variable hare to the Proceedings of the Zoological Society of London for 1899. The fact that the vernal color-change is due to a shedding of the coat seems, however, as already mentioned, to have been much more generally admitted than was the case with regard to the autumnal transformation.

Dr. Allen arrives at the conclusion that both the autumn and the spring change take place periodically and quite independently of the will of the animal, and also that they are but little affected by phases of the weather, although they may be somewhat retarded or accelerated by the prevailing atmospheric temperature.

So far as the fact of the seasonal change being normally beyond the control of the animal in which it occurs, Mr. Barrett-Hamilton is in full accord with the American writer; but he goes somewhat further, and believes that it is quite uninfluenced by temperature or at least by such variations of the same as may be met with in different parts of the area of the British Islands; and, as we all know, these are considerable.

As in the case of many other animals—deer, for instance—the change from the winter to the summer coat takes place very late in the season in the mountain hare in Scotland, specimens undergoing the change being often taken early in May. But the date of the spring change is no earlier in the South of Ireland, where the climate is much milder, although the amount of whiteness assumed in that district is very much less than in the North. This seems to demonstrate the contention that temperature has little or no influence on the change, so far as season is concerned.

That the animal has no control over the change from brown to white in autumn seems to be proved by instances referred to by Mr. Barrett-Hamilton, "in which variable hares transported from Scotland and from Irish mountains to southern and low-lying regions continued for some seasons to appear in the northern garb of snowy whiteness. This persistence of the habit of turning white, even in unsuitable conditions, together with the lateness of the moult, resulted frequently in the curious spectacle of a mountain hare running about in all its conspicuous arctic livery under the bright rays of an April or May sun. After a few years such imported hares, or more probably their offspring, ceased to turn completely white, and the breed assumed the appearance of the ordinary hares of the southern locality to which they had been transported."

It would, of course, be extremely interesting to ascertain whether such transported individuals ever do give up the practice of turning white in winter, or whether it is only their offspring that do so; but, in any case, it is clearly demonstrated that the habit is very deep seated and difficult to overcome.

Very curious is the circumstance that the mode in which the coat is changed in the variable hare at the two seasons of the year differs *in toto* as regards the parts of the animal first affected. On this subject, with one verbal change in the first sentence, we may quote from Dr. Allen, who writes as follows:

"In the fall the change begins with the feet and ears, the sides of the nose and the front of the head, which often become radically changed before the body is much affected; while as regards the body, the change begins first at the base of the tail and extreme posterior part of the back, and at the ventral border of the sides of the body, working thence upward toward the middle line of the back, and from behind anteriorly, the crown of the head and a narrow median line over the shoulders and front part of the back being the parts last changed. In the spring the order of change is exactly the reverse, the moult beginning on the head and along the median line of the anterior half of the dorsal region, extending laterally and gradually to the ventral border of the sides of the body and posteriorly to the rump, and then later to the ears and down the limbs to the feet, which are the parts last affected, and which often remain but little changed till the head and body have pretty completely assumed the summer dress."

It is very hard indeed to conjecture any satisfactory reason for this remarkable difference. The American variable hare ranges, at ordinary levels, about as far south as Massachusetts—that is to say, nearly to the latitude of Madrid—and throughout the whole of this extensive tract it turns white in winter. On the other hand, owing to the much milder climate of western Europe, no color-change takes place in the mountain hares of Ireland, while it is reported that in those introduced in Ayrshire and the neighboring counties of southwestern Scotland the change is much less complete and regular than in those inhabiting the northern parts of the country.

An impression appears to be prevalent that in the more northern portion of their range both the mountain hare and the ermine (or stoat) are white at all seasons, but this does not seem to be authenticated.

Observations are wanting as to whether the changes of coat and color in the mountain hare bear any relation to the appearance and disappearance of snow, or whether they occur regularly at the same season of the year. In the case of the ermine in the Adirondack region of New York, Dr. C. H. Merriam tells us that in this animal the white livery is assumed only after the first fall of snow, while the resumption of the brown does not take place till the snow begins to melt. Unfortunately he says nothing in regard to change of coat. The late Dr. Coues stated, however, that in the case of the ermine the bi-annual change of coat takes place at the same season, but that it depends upon the condition of the temperature at the time whether the new coat differs in color from its predecessor. In other words, the change from brown to white might be due either to shedding the coat or to bleaching of the hair subsequent to such shedding. The case of the mountain hare is, however, strongly suggestive that the color-change is in all instances coincident with the shedding of the coat.

It is, of course, quite evident that the assumption of a white winter livery by mountain hares and ermines living in regions where the snow lies on the ground for a considerable portion of the year is for the purpose of rendering such animals as inconspicuous as possible when in their native haunts. And, so far as we know, such a change is universal among the species named when dwelling in high northern latitudes.

There is, however, another animal inhabiting the north polar regions of both hemispheres in which the change to a pure white winter dress is limited to certain individuals. The species in question is the Arctic fox, of which the beautiful fur, in both the white and the blue phase, is now much affected by ladies. That both the white and the blue individuals of this species are in the winter dress will be evident to every one who examines such furs carefully; the length and thickness of the hair being quite decisive on this point.

As it has been stated in several works that the white is the winter and the blue the summer phase of the Arctic fox, it may be well to quote from a letter written to me in answer to inquiries on this subject by Dr. Einar Lönnberg, of Upsala, whose observations are based on personal experience:

"The 'blue' foxes are uniformly dark-colored both summer and winter, and do not change to white at any time. In summer they are very dark—dark brown, in fact; in winter they are also dark, but more bluish. The individuals which turn white in winter are during the summer ashy gray on the upper parts

* See G. B. Poulton, "The Colors of Animals," Chapter vii. (1900).

and limbs, but have the tail, underparts, more or less of the flanks, and the ears and muzzle white. The distribution of the gray and white is, however, subject to individual variation. The blue fox is, in fact, merely an individual variety of the white one. Both breed together, and sometimes there are dark and light individuals in the same litter. A friend of mine observed on Bear Island a pair in which the female was white and the male blue. In Iceland it is stated that all the Arctic foxes are blue."

With this single exception it appears that the white and the blue phase are met with throughout the habitat of the species. In other words, the animal is "dimorphic," if it be permissible to apply this term to a case where the difference between the two phases of a species is restricted to coloration.

What makes the matter so puzzling is that if "blue" foxes are able to thrive during winter in a snow-clad country, what necessity is there for their fellows—and, indeed, for any species—to turn white at that season of the year?—Knowledge.

PHOTOGRAPHIC NOVELTIES.

The Lesueur "Sinnox."—In all apparatus in which glass plates are employed, recharging by daylight is impossible, unless the plates have been first inclosed in frame or some other device; and such operation can be performed only in darkness or a red light. The great advantage claimed by manufacturers for film in rolls is that it can, without any preparation, and just as it is found in the market, be put into and removed from the apparatus in broad daylight. M. Lesueur, who is a manufacturer of glass plates, has desired to give the same facility for the use of these, by means of a peculiar mode of packing, and of an apparatus called the "Sinnox," especially constructed for the purpose, and that may be introduced directly into the apparatus just as it has been purchased. Through the mere maneuvering of the drawer of the sinnox, the box opens and the plates arrange themselves in succession in the focus of the objective; and then, in measure as they are used, they are repacked in the same box, which may always be removed from the apparatus at any moment in broad daylight.

The method of packing the plates consists in gluing them by the four corners to a sheet of black paper of slightly larger size, and in afterward piling them one upon another in a cardboard box. This latter does not open in the usual way, but rather after the manner of a cigar case. It is represented half open to the left of the engraving in Fig. 1. The part that has received the plates slides in a cardboard case that envelops it completely. In the figure, a portion is removed in order to show the interior, in which the first plate is concealed by black paper. The upper part of the box terminates in a sheet of cardboard that overlaps it slightly on all sides so as to form a cover in resting upon the edges of the case, after the box has been slid to the bottom. The imperviousness to light is assured by connecting this cover with the case by paper glued thereto externally, and that is slit with a penknife at the moment of using the box. The entire package of plates is held by a pin that traverses the cardboard of the box and all the papers at the upper part; so that if the box be held vertically and the edge of the cardboard cover be grasped, and the case be drawn with the other hand, the case may be removed without the plates falling out. It will be seen in our engraving that the bottom of the paper support is cut into steps and is provided with apertures. The paper is doubled in this place in order to make it stronger. If we suppose the box to be closed, and we pass a needle through the bottom of the case in such a way that it shall traverse one of these apertures, it will be seen that when the box is package of plates does not move, and the first sheet, *D*, is exposed. When the drawer is pushed in again, the sheet ascends against the plate, and the case closes. When the pin is inserted in aperture No. 2, the first paper is traversed as before, as is the paper-support, and things proceed as in the first place, save that it is the plate that has been used that is carried along. In order that the focusing may be effected automatically, the apparatus is formed of two boxes, *H* and *E*, that slide one within the other, and a spring causes the interior extremity of *E* always to bear against the plate that is exposed. In order to close the drawer, *B*, it suffices to pull the front of the camera forward. Any make of objective or shutter may be used, and the same may be said of the plates.

The Pankoras.—Although magazine apparatus are now very extensively employed, there are still many partisans of the separate frame apparatus. MM. Ducom and Echassoux, in devising the "Pankoras," have endeavored to combine the advantages of both systems in twin lens or detective cameras provided with all the latest improvements. It is the charging of the apparatus that is especially interesting (Fig. 2, No. 1). The plates are put into metal holders, *A*, 0.15 of an inch in thickness, closed by a slide consisting of a plate of sheet iron sliding in grooves and capable of being entirely removed.

The rear of the apparatus is arranged in such a way that it can receive six of these holders placed one against the other, so as to form a magazine. As soon as a plate has been exposed, the slide of the holder is closed and the holder is expelled from the magazine by pressing upon a lever. All that has to be done then is to place it by hand behind the others, when the following holder will be in place for use. An aperture formed in the door, *P*, that closes the magazine permits of seeing the number of frames used. One of the advantages of this system is that it permits of the use of various makes of plates. As it is always possible, when desired, to effect the focusing upon the ground glass and to employ any holder of the series, a certain number of the latter may be charged with anti-halo plates, and others with orthochromatic ones.

The "Pliant."—This $4\frac{1}{2}$ x 6-inch apparatus, constructed by M. Dommartin, is designed for the use of separate metal holders of slight thickness. The back (Fig. 2, No. 2) carries the ground glass, in the place of which slides the holder at the moment of operating. The front carries the objective and shutter mounted upon a sliding device. These two parts are connected by a slightly conical bellows, and metallic joints permit of placing one against the other, when the apparatus is not in use, so as to reduce the bulk of the whole. The focusing is effected by acting upon one of these joints by means of an eccentric controlled by a lever, *M*, the extremity of which engages in notches, *F*, carrying a graduation scale for focusing at different distances. The entire apparatus is of inoxidizable metal—an alloy of copper and aluminium—and is well adapted to the needs of explorers, who have to contend against heat and humidity.

The Fetter Apparatus.—In devising this apparatus, M. Fetter seems to have aimed to prevent any entrance of light at the moment of the opening of the plate holder. The fact is well known that in cameras in which plate holders are employed there are often difficulties to overcome, and photographers who operate with such apparatus are in the habit of enveloping them with a black cloth at the moment of opening the shutter. M. Fetter's plate holders (Fig. 3) open like a book, the hinge being placed crosswise.

In order to place one of them in the apparatus, we open the door that closes the back of the latter and place the holder therein in such a way as to engage the two small rods, *A B*, that are carried by its back shutter in the fork, *C D*, that terminates the movable frame, *H*, fixed upon the door, which is afterward closed. The holder is thus entirely inclosed in the camera. In order to open it, it suffices to maneuver a small lever, *M*, situated at the side of the apparatus, and which is integrally formed with the frame, *H*. The latter swings toward the front, and, in its rotary motion, carries along with it the front shutter of the holder, while the back one, which carries the plate, is held in place by a rabbet formed in the apparatus. The closing is effected by a contrary maneuver. A bolt device at the top of the holder assures the closing of it when it is outside of the apparatus.

The camera consists of a wooden frame and a flexible leather bellows. Two metal plates, one of which carries the objective and its cap, permit of folding up the whole in such a way as to present the least bulk possible.—For the above particulars and the engravings, we are indebted to La Nature.

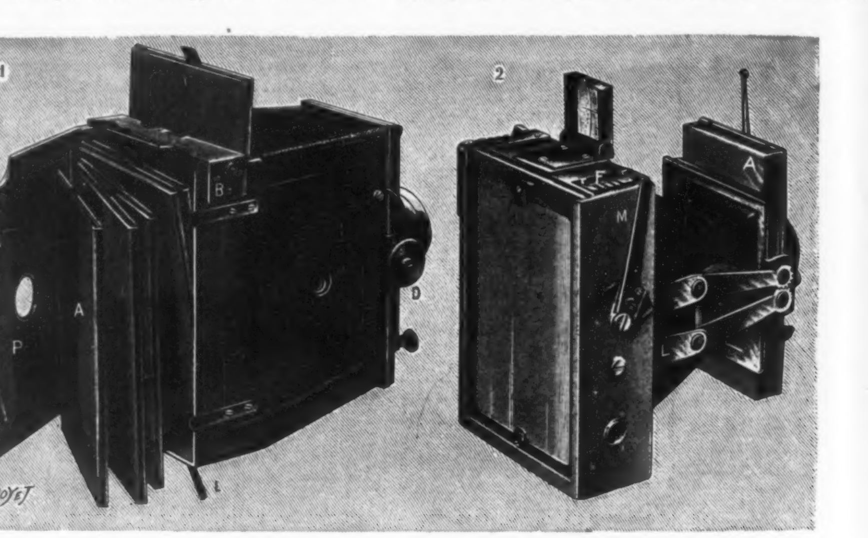


FIG. 2.—1. THE DUCOM AND ECHASSOUX "PANKORAS." 2. THE DOM-MARTIN "PLIANT."

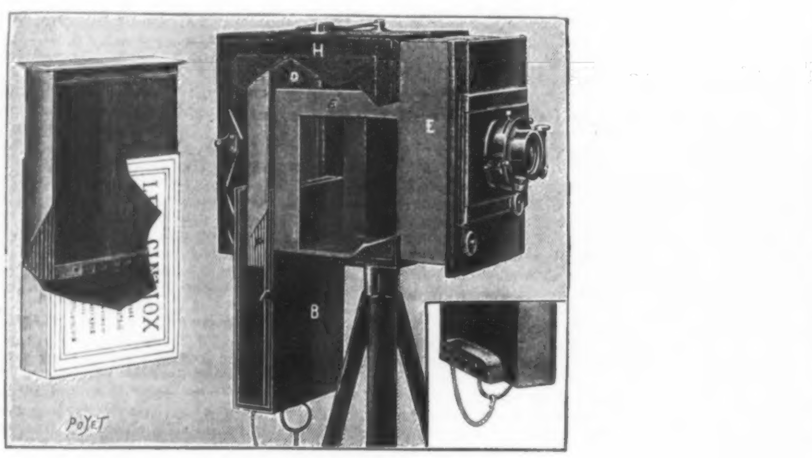


FIG. 1.—THE LESUEUR "SINNOX."

afterward opened, the sheets traversed by the needle will be carried along when the case is drawn out. The paper of the sheets thus carried along will be easily torn at the upper part where it is held by the pin. In descending with the case, the plates and their support will uncover the plate situated behind them. Things are so arranged as to go on methodically in this manner. The box is introduced into a drawer placed at the back part and provided at the lower part with a block containing apertures lined with rubber and into which may be inserted a steel pin provided with a head and connected with the block through a small chain (see cartouche to the right of the engraving).

These apertures are situated opposite those formed in the paper-support. When the pin is placed in aperture No. 1, only the first sheet that serves to mask the first plate is traversed. Then the operator pulls out the drawer, which takes the position, *B*, in carrying with it the case, *A*, and the punctured sheet. The

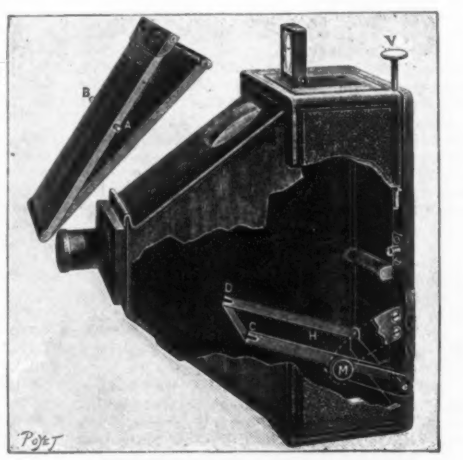


FIG. 3.—THE FETTER APPARATUS.

DEVELOPMENT OF THE KENTUCKY ASPHALT DEPOSITS.

NEW developments in connection with the deposits of asphalt rock in central western Kentucky are impending. There seem to be great possibilities in the enterprise, and material modification of the business of laying asphalt streets may result. Quietly certain strong interests have aggregated into one organization the separate holdings of almost the entire number of the deposits of asphalt rock and now state that they are prepared for effective work and active operation on a large scale.

There are about ninety different deposits in the State of Kentucky, ranging in size from 5 acres to 500, situated in the counties of Edmonson, Grayson and Hardin, with a few in the adjoining counties. The section of country in which the deposits occur is somewhat irregular in shape, but is about 30 miles long and probably 10 miles in its greatest width. The asphalt rock is called by the natives "black rock," and is found in ledges of sandstone in the upper formations and only on the higher plains and hills. It has not been found excepting in the peculiar geological formation of this section of the State.

The rock contains asphalt of pure quality, entirely free from organic matter, the only other constituent of the rock being white quartz sand. The percentage of asphalt in the rock varies from 4 to 18. The principal claims are: That the particles of sand cannot be so completely covered and joined together in an artificial mixture as they are in nature; that the asphalt rock is free from clay, vegetation and other organic matter and does not require the addition of petroleum, oils, sand and limestone to make a paving material; that genuine asphalt rock has existed unchanged for infinite time and pavements made of it are unchangeable with time and with temperatures of summer or winter.

The location of these deposits is in the heart of the central part of the State, having railroads crossing it, giving transportation by rail from the mines to every city in the country, and having navigable intersecting rivers giving water transportation to the cities on the Mississippi, Missouri and Ohio Rivers and their tributaries. The facilities for distribution of the material are thus practically unequaled.

The crude asphalt rock has been crushed and laid as a pavement, but thus laid it usually proves too soft at least for the first summer. Recognizing the initial softness of asphalt work and its disadvantages to the public, the practical scientists engaged in the work have developed a special process to which the crude rock is subjected in the works at the mine, which is claimed to remove the difficulty. The material thus prepared is shipped to the place of use and can be laid, it is said, without skilled labor or expensive plant. Should this claim be established many small cities, towns, corporations and individuals, who have hitherto been barred from the advantages of asphalt work because it was not of sufficient magnitude to justify the large expense required for a mixing plant, can avail themselves of the benefits of this class of pavements. These features of what promises to become an important factor in the paving business will be of interest to many of our readers, and we are advised that, to those who desire it, further information will be furnished by the promoters.—Municipal Engineering.

ELECTRICALLY-OPERATED PUMPS.

By FRANK C. PERKINS.

ELECTRICALLY operated centrifugal pumps are especially suitable for handling large quantities of water quickly, such as emptying drydocks and coffer dams, draining land, and pumping sewage. A centrifugal is the simplest type of pump, and therefore the first cost and maintenance is less than other types. It is also understood that, as there is no reciprocating motion, the discharge is free from pulsations, and hence the necessity of air chambers is avoided. They are frequently used for irrigation purposes.

A very large centrifugal pump was made by Joseph Farcot, of Saint-Ouen (Seine), France, and installed in Egypt for the irrigation of the "Province du Behera" at the works for elevating the water of the River Nile at Khatatbeh, more than 2,500,000 cubic meters of water being raised every twenty-four hours. The pump is seven meters in diameter and nearly four meters high, while the inlet is 3 meters, or about 10 feet, in diameter. It is said to deliver from six to ten cubic meters of water per second.

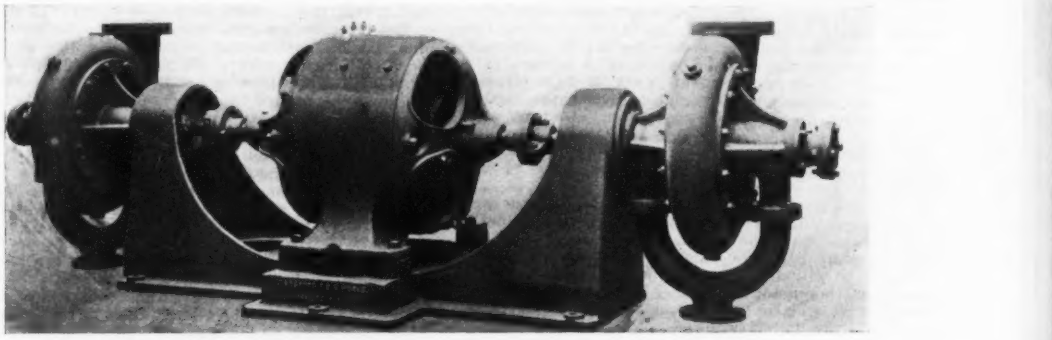


FIG. 1.—KINGSFORD DOUBLE ELECTRICALLY-DRIVEN PUMP.

The entire absence of valves and plungers allows the pump to pass solids, as found in sewage, which would positively interfere with the successful operation of a pump depending upon valves.

It is not only claimed for the centrifugal pump that it occupies a very small space, but it is said that it will discharge a greater volume of water, for its size, than any other type of pump, while the foundation required is comparatively small. Many large iron and steel works have adopted centrifugal pumps for supplying water under low heads for blast furnaces and condensers, while they have been particularly well adapted for circulating water in surface condensers. The "Kingsford" double electric-driven pump, shown in Fig. 1, was designed at the Kingsford Foundry and Machine Works, at Oswego, N. Y. It has self-oiling bearings, solid scrolls or shells and a removable suction-head which permits of examination of the interior of the pump without removal from the base or bed. The electrically-driven pump is particularly applicable where the pump is located at a distance from the boiler plant, as it avoids the running of long steam pipes and consequent condensation, or the necessity for additional boilers, with increased attendance, and provision for handling coal and ashes at the site of the pump, the simple running of the wires being all that is required.

Centrifugal pumps are particularly adapted for driving by electric motors on account of their comparatively high speed, and during the past few years may have been used ranging from a few inches up to several feet discharge. Owing to their noiseless operation, the little and unskilled attention they require, and the ease with which they can be erected and maintained, such outfits are coming more and more into extensive use. While it is more simple and satisfactory to use the direct-connected motor and runner, it is frequently found desirable to use gearing in order to obtain the proper pump speed, in order to use a high speed and less expensive motor, and for low heads this can be easily done.

The American type of electric motor pumps is well illustrated by the outfits built by the Erie Pump and Engine Company, the Morris Machine Works, of Baldwinsville, N. Y., and the Lawrence Machine Company, of Lawrence, Mass. The electrically-operated centrifugal pump is especially desirable where it is necessary to handle acids, sand, pulp or anything of a semi-fluid nature, in large or medium quantities. It stands without a peer for work of the character required in paper and pulp mills, tanneries, bleacheries, breweries, sulphite and phosphate works, white lead works, ice factories and refrigerating plants.

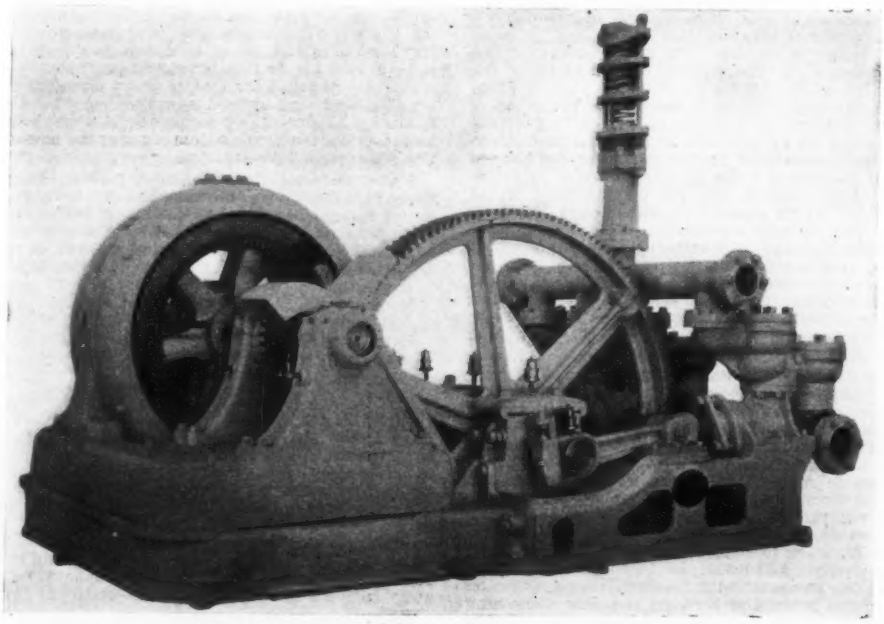


FIG. 2.—KNOWLES TRIPLEX HORIZONTAL ALTERNATING ELECTRIC MINING PUMP.

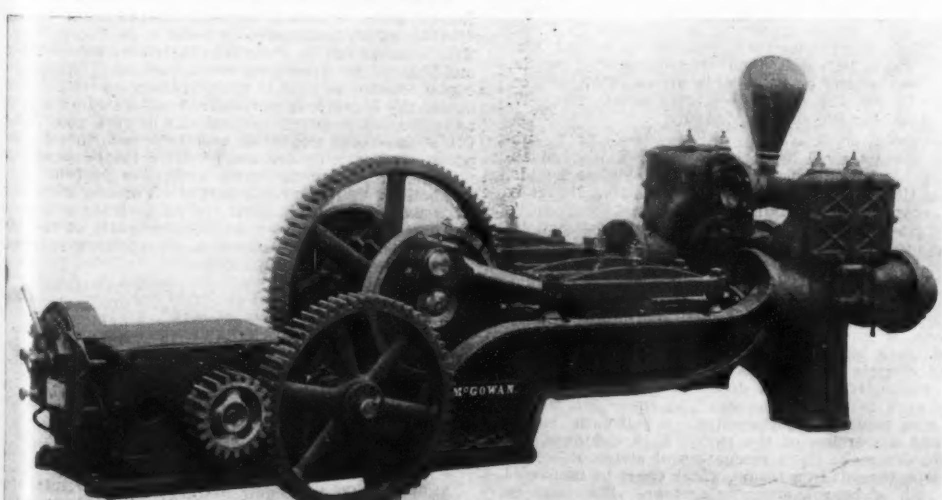


FIG. 3.—ELECTRICALLY-OPERATED BOILER FEED PUMP.

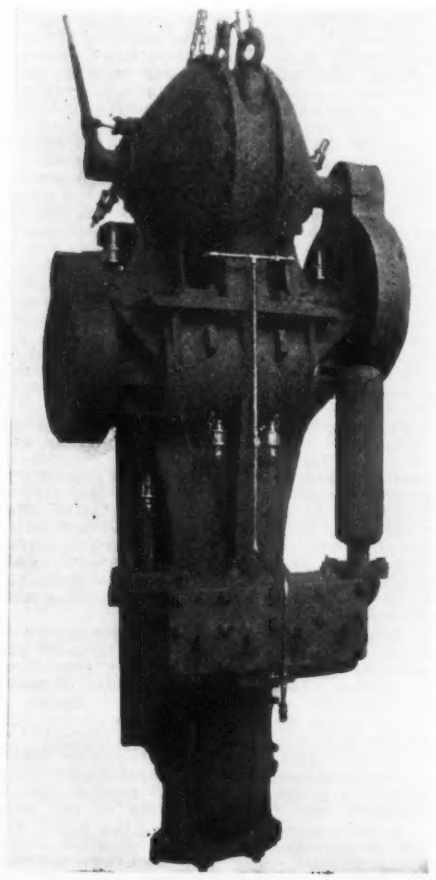


FIG. 4.—KNOWLES ELECTRIC PUMP FOR 400-FOOT HEADS.

For mine pumping services the electric motor is started by either a hand switch or by an automatic switch, consisting of a ball-float connected with a copper chain to the switch handle, and properly counterbalanced to allow it to move easily with any change of water level in the tank. The plant thus

becomes entirely automatic, starting up when the tank is nearly empty and stopping when nearly filled, or if for draining, starting when the tank is nearly filled and stopping when nearly empty, and requiring no attention whatever beyond an occasional oiling of the pump bearings.

In equipping public buildings, office buildings and apartment houses with an adequate supply of water for general use, electricity as a motive power is especially desirable. The cost of operating the ordinary steam pumps, as well as the smoke, ashes and direct results, are objectionable features that are entirely overcome. The cost of attendance is also materially reduced. Many buildings have individual electric plants and the additional power required for operation of the pumps is very small; if, however, such a plant is not at hand, all that is necessary is a connection with a convenient power or light circuit, and by employing good automatic devices practically no attention is required other than cleaning and oiling.

The illustration, Fig. 2, shows the Knowles Triplex Alternating Electric Mining Pump, which is of the horizontal type 6½ inches by 82.

Boiler-feed pumps of the horizontal duplex type are also designed to be electrically operated, as that built by the John H. McGowan Company, of Cincinnati, Ohio, seen in Fig. 3. This is a combined duplex crank electrically-driven power pump, and it will be noted that the motor is of the iron-clad, continuous current type, and controlled from a starting rheostat attached to the motor frame.

One of the most celebrated pump manufacturing firms in the United States is Henry R. Worthington, of New York, and the illustration, Fig. 4, shows a Worthington pump which gives a good idea of recent types of small pumps electrically operated. It can be used for a variety of purposes, but is especially intended to supply the reservoir tanks of residences or office buildings where the pressure carried on the city main is not sufficient to elevate the water above the lower stories. They can be located anywhere where the electric current is available, and require little or no attention after once installed. The capacities are usually from 250 to 500 gallons per hour and the actual amount of power consumed varies between ¼ to 1 horse power, depending upon the head pumped against. The noise of this type is small, as there are no gears, the motor being connected by a belt running over an idler. The idler is acted upon by a spring keeping a constant tension on the belt.

Electrically-operated pumps are not only used for all of the purposes before mentioned, but they are coming into extensive use for hydraulic elevator service, waterworks supply, and are very well adapted for fire protection pumping. In no distant day many of our leading fire departments will be supplied with electric fire pumps.

The supplying of towns and cities with an adequate amount of wholesome water, and at a minimum cost, is a problem that has engaged the attention of eminent engineers for years. Many cities can combine their lighting and water supply plants in one. Even in instances where the plant could not be centrally located with convenience, the power plant with generators could be located at a point most convenient for lighting, and direct current or multiphase motors, direct connected to triplex pumps, could be installed at a point where pure water is obtainable. Storage reservoirs, or stand pipes of sufficient capacity, could be constructed and the day's supply of water could be pumped at night, when the lighting plant is in operation, the heavy pumping load being used during the latter part of the night when the lighting load is small and during the day when few lights are required for even incandescent service. The operation of small lighting plants as well as pumping plants could then be economically carried on, and the objections heretofore urged against either lighting or pumping plants for small cities on account of cost of operation could be obviated. Many electric pumps are now in operation for municipal water supply, notably at Alpena City, Mich.; "Bon Air" Pumping Station, Augusta, Ga.; Anderson, S. C.; Chippewa Falls, Wis., and Hanford, Cal.

At Chambersburg, Pa., there has been installed an electrically-operated Smith-Vaile triplex pump capable of delivering 2,000,000 gallons of water in twenty-four hours.

For mining work a more economical pumping plant than either steam or compressed air has long been desired. The distance that either steam or compressed air has to be carried in many cases renders economy impossible, and in many instances it is not practical to generate steam in shafts. The power developed at a central plant and applied to a triplex pump at a station where the pump is needed is an economical solution of the difficult mine pumping problem. The shaft is then freed from machinery, only the discharge pipe and conductors occupying space therein.

The efficiency of the triplex pump, its ability to handle gritty water without detriment to itself, and freedom from repairs, render this type of great value for this service. There are also a number of heavy pressure horizontal triplex pumps on the market of the pot valve type which are well adapted for mine service even under extreme heads.

The electric sinking pump is a Knowles duplex sinker, and is equipped with a General Electric iron-clad motor, to insure it as far as possible against the dampness and possible flooding of the mine shaft. As the case is water-tight, the pump will work when completely "drowned," as often occurs in sinking a shaft. The gear teeth are carefully protected by iron guards, and these pumps are designed to be used under heads of from 300 to 400 feet. These pumps are supplied by the Deane Steam Pump Company, of Holyoke, Mass.

CONTEMPORARY ELECTRICAL SCIENCE.*

SIMPLIFIED LIQUID INTERRUPTER.—D. A. Goldhammer and J. J. Ariston describe a new arrangement of Simon's interrupter which appears to have some distinct advantages. The porcelain diaphragms are represented by the walls of porcelain beakers. The wall is bored down until it is thin, and then a small hole is punched into it by a light tap with a hammer on a needle. This gives holes from 0.2 millimeter to 4 millimeters wide, with walls a few tenths of a millimeter thick. The durability of the porcelain is something quite extraordinary, and indicates porcelain as the ideal material for interrupters of this kind. The beakers used by the authors are 10 centimeters wide and 10 centimeters high. This insures that for ordinary currents there is very little heating of the liquid. To still further reduce the heating the authors employ two or more cells in parallel, joining the inner vessels with a siphon. If the current passes in opposite directions in the interrupters any change of level in one of the inner vessels will be compensated by a rise or fall of the liquid in the other. As a further advantage, the resistance of the interrupter is diminished. No cooling device is needed in this arrangement. The liquid is covered with a layer of vaseline oil. The cost of the apparatus is trifling.—Goldhammer and Ariston, Phys. Zeitschr., June 22, 1901.

POINT DISCHARGES.—Donle, after his experiments with an arrangement similar to Lecher's, put forward the supposition that very rapid electric oscillations favor the discharge of positive electricity. At greater distances between the point and the plate he found, however, that the plate was often negatively charged instead. Knoblauch (see The Electrician, Vol. xlvi., p. 381) showed that two different cones of discharge proceed from the point—a longer and outer one of negative electricity and a shorter inner one of positive electricity. It is only the latter that acts at short distances, while the former acts at longer distances. K. von Wesendonk was led to the idea that the excess of negative electricity from Tesla discharges might be only apparent. To test this he operated with large screens and with hollow metallic spheres surrounding the discharging point. With an ordinary influence machine, provided with its own condensers, the electrification received had invariably a positive value, so that it must be concluded that there was more positive than negative electricity given off by the point. The author believes that if there is any real prevalence of negative electricity in Tesla discharges, it is connected with their comparatively low frequency. He does not appear to consider the influence of light.—K. von Wesendonk, Phys. Zeitschr., June 8, 1901.

ELECTRIC DISSIPATION AT HIGH ALTITUDES.—The presence of ions in the air was suggested by the phenomena of photo-electric discharges observed by Elster and Geitel, and has been explained on the basis of the ultra-violet rays in sunlight. Observations made on mountain tops are complicated by the increased electric density inseparable from points and eminences, and these complications can only be removed by measurements made in balloons. H. Ebert undertook two balloon ascents for the purpose of determining the conductivity of air at high altitudes. One of them was undertaken in the hot summer, and the other in winter, with snow on the ground. Even in the case of a balloon ascent a new complication might conceivably be introduced by a proper charge of the balloon itself, but the author made sure against that by bringing the inflated balloon into the neighborhood of the electrometer, which showed no disturbance in consequence. The general observation made was that as the altitude increased the ratio between the rates of discharge of negative and positive electrification became more and more like unity, and at the same time both rates of discharge showed a notable increase. But the excess of positive over negative ions may often be felt at altitudes as great as 8,000 feet.—H. Ebert, Ann. der Physik, No. 7, 1901.

ELECTROMAGNETIC THEORY OF MECHANICS.—The leading ambition among electrical theorists has been to reduce electromagnetics to mechanical conceptions and principles. This tendency is probably due to the notion that mechanical actions are somehow more real, palpable and intelligible than the play of electrical and magnetic forces. This idea is, of course, quite erroneous, since the intimate mechanism of a simple contact or impact is quite as mysterious as the attraction of two oppositely electrified bodies. The attempt made by W. Wien to reduce mechanics to electromagnetic conceptions and principles is, therefore, of great interest. He assumes, with Lorentz, that gravitation is due to the attraction between the ions composing the material bodies, and that the attraction between positive and negative ions surpasses the repulsion between ions of the same class. The ether is supposed to be at rest. Gravitational force must be propagated with the velocity of light, and must be modified by the motion of bodies. This, in the case of the fastest cathode rays, would involve a modification of 7 per cent. The other fundamental property of matter, viz., inertia, would be based upon electromagnetic inertia. These speculations open up wide vistas in mechanics, which will put the theory to a very severe test.—W. Wien, Ann. der Physik, No. 7, 1901.

ABSORPTION OF WAVES BY RESONATORS.—If a substance, characterized by a strong and well-marked absorption band, is dissolved in various colorless liquids, the position of the absorption band varies in many cases according to a definite law, expressed by "Kundt's rule." The band is displaced toward the red end by an amount proportional to the refractive and dispersive powers of the solvent. According to Garbasso's observations a system of resonators transmits an incident electric radiation the less the more its own period coincides with that of the incident radiation. If, for instance, a number of parallel metallic strips are pasted on a glass plate such a "resonator" behaves toward electric rays in much the same manner as a body with surface colors does toward rays of light. When such resonators are built in three dimensions it is even possible to demonstrate a prismatic refraction and dispersion of the rays. E. Aschkinass and C. Schaefer make their resonators of strips of copper strung on threads in a frame, which could be immersed in a bath of benzol, ether or acetone. They noticed a decided displacement of the maximum absorption, which was at a resonator length of 4.7 cm. in air, 3.1 cm. in benzol, 2.3 cm. in ether, and 1 cm. in acetone.—Aschkinass and Schaefer, Ann. der Physik, No. 7, 1901.

*Compiled by E. E. Fournier d'Albe, in The Electrician.

SELECTED FORMULÆ.

Cough Candy.—

MONTPELIER COUGH DROPS.

Brown sugar	10	pounds
Tartaric acid	2	ounces
Cream of tartar	½	ounce
Water	1½	quarts
Anise seed flavoring		q. s.

Melt the sugar in the water, and when at a sharp boil add the cream of tartar. Cover the pan for five minutes. Remove the lid and let the sugar boil up to crack degree. Turn out the batch on an oiled slab, and when cool enough to handle mold in the acid and flavoring. Pass it through the acid drop rollers, and when the drops are chipped up, and before sifting, rub some icing with them.

MEDICATED COUGH DROPS.

Light brown sugar	14	pounds
Tartaric acid	1½	ounces
Cream of tartar	½	ounce
Water	2	quarts
Anise seed, cayenne, clove, and peppermint flavoring		a few drops of each

Proceed as before prescribed, but when sufficiently cool, pass the batch through the acid tablet rollers and dust with sugar.

HOARHOUND CANDY.

Dutch crushed sugar	10	pounds
Dried hoarhound leaves	2	ounces
Cream of tartar	¾	ounce
Water	2	quarts
Anise seed flavoring		q. s.

Pour the water on the leaves and let it gently simmer till reduced to three pints; then strain the infusion through muslin, and add the liquid to the sugar. Put the pan containing the syrup on the fire, and when at a sharp boil add the cream of tartar. Put the lid on the pan for five minutes; then remove it, and let the sugar boil to stiff boil degree. Take the pan off the fire and rub portions of the sugar against the side until it produces a creamy appearance; then add the flavoring. Stir all well, and pour into square tin frames, previously well oiled.

MENTHOL COUGH DROPS.

Gelatine	1	ounce
Glycerine (by weight)	2½	ounces
Orange-flower water	2½	ounces
Menthol	5	grains
Rectified spirits	1	drachm

Soak the gelatine in the water for two hours, then heat on a water-bath until dissolved, and add 1½ ounces of glycerine. Dissolve the menthol in the spirit, mix with the remainder of the glycerine, add to the glyco-gelatine mass, and pour into an oiled tin tray (such as the lid of a biscuit box). When the mass is cold divide into ten dozen pastilles.

Menthol pastilles are said to be an excellent remedy for tickling cough as well as laryngitis. They should be freshly prepared, and cut oblong, so that the patient may take half of one, or less, as may be necessary.—The Pharmaceutical Era.

White Dressing for Coachmen's Gloves, Boot-Tops, Etc.—Pipe-clay and water have hitherto been depended on for this purpose, but the following, which appeared some time ago in the Seifensieder Zeitung, seems to be an improvement on this old-time method, so roundly damned by soldiers and others having much of it to do:

Water	136	parts
Fine pipe-clay	454	parts
Shellac, bleached	136	parts
Borax, powdered	68	parts
Soft soap	8.5	parts
Ultramarine blue	5.5	parts

Boil the shellac in the water, adding the borax, and keeping up the boiling until a perfect solution is obtained, then stir in the soap (5 or 6 parts of "ivory" soap, shaved up, and melted with 2 or 3 parts of water, is better than common soft soap), pipe-clay and ultramarine. Finally strain through a hair cloth sieve. This preparation, it is said, leaves absolutely nothing to be desired. We should imagine, however, that a good deal of stiffness would be imparted to the leather by it. The addition of a little glycerine would probably remedy this. The old application should be wiped away before a new one is put on.—National Druggist.

Effervescent Bath Tablets.—

Tartaric acid	10 parts
Sodium bicarbonate	9 parts
Rice flour	6 parts

A few spoonfuls of this when stirred into a bathtubful of water causes a copious liberation of carbon dioxide, which is thought by some to be "refreshing." This mixture can be made into tablets by compression, moistening, if necessary, with alcohol. Water, of course, cannot be used in making them, as its presence causes the decomposition referred to. Perfume may be added to this powder, essential oils being a good form. Oil of lavender would be a suitable addition in the proportion of a fluidrachm or more to the pound of powder. A better but more expensive perfume may be obtained by mixing one part of oil of rose geranium with six parts of oil of lavender. A perfume still more desirable may be had by adding a mixture of the oils from which Cologne water is made. For an ordinary quality the following will suffice:

Oil of lavender	4 fluidrachms
Oil of rosemary	4 fluidrachms
Oil of bergamot	1 fluidounce
Oil of lemon	2 fluidounces
Oil of clove	30 minims

For the first quality the following may be taken:

Oil of neroli	6 fluidrachms
Oil of rosemary	3 fluidrachms
Oil of bergamot	3 fluidrachms
Oil of cedrat	7 fluidrachms
Oil of orange peel	7 fluidrachms

A fluidrachm or more of either of these mixtures may be used to the pound, as in the case of lavender.

These mixtures may also be used in the preparation of a bath powder (non-effervescent) made by mixing equal parts of powdered soap and powdered borax.—Merck's Report.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Corundum Deposits of Canada.—Consul-General Bittinger, of Montreal, sends the following: Corundum is an article of great use in the industrial world, for its very high abrasive powers, being used instead of emery as a grinding material. Emery is, in fact, but an impure and, consequently, much inferior grade of corundum.

Corundum, until recently, was very little used, as the expense of its mining and its rarity kept its price too high for general use. But the deposits in Ontario are of such value and are so easily worked that it is expected it will henceforth be placed on the market at a more reasonable price. Corundum is a compound of aluminium, and is of the same material as the sapphire and ruby, merely lacking their brilliant colors.

The Ontario deposits lie north of Kingston, and cover a large area. The corundum occurs along with mica and other substances. It is tamped up into powder and separated from the rest of the rock by washing, its weight being much greater than that of the other constituents of the rock. The deposits have only recently been discovered, and are as yet almost undeveloped.

A company is starting to work some of the deposits purchased from the government. The specimens so far tested have proven rich, and the extent of the deposits is probably quite large, though that has not been thoroughly investigated. There is no impediment in the development of these mines at present. They are easily worked, rich in the mineral, and conveniently situated, so that transportation will be cheap.

With the discovery of the corundum deposits in such pure condition has arisen the somewhat vague hope that its more precious relations, the ruby and the sapphire, might also be found in the same region, and this has led to considerable investigation. In some places corundum has been found which shows plainly the blue line of the sapphire, but as yet no real gems have been discovered.

Corundum of a very high grade—viz., 95 per cent pure—is now being produced at Combermere by the Canada Corundum Company. When it is remembered that manufacturers have heretofore been satisfied with an 80 per cent product, the outlook for the Canadian industry seems bright.

The Canadian deposit is found in the Apalachian Mountain range which runs through the eastern townships of Quebec, and as the rock formation is the same as in North Carolina, there is every reason to believe that corundum exists there also.

Proposed Cable to Hongkong.—In connection with the proposed construction of a cable from the United States to Manila and its eventual connection with Hongkong, I have to report that the business community of Hongkong takes a keen interest in obtaining additional cable facilities. The excessive rates charged by the present cable companies have been a source of long-continued dissatisfaction, and an American cable company that would be the means of reducing rates would be extremely popular in the Orient, and should receive a large share of local patronage.

The present cable tariff between the United States and Hongkong is from $1.65 to $1.75 (United States currency) per word. It is reported that an American cable company would establish a rate not exceeding $1 a word. Such a reduction would be a great boon to the business men in the Orient. The chairman of the Hongkong Chamber of Commerce last month, at my suggestion, brought the matter before the committee of the chamber, and this representative institution indorsed the project, expressing the opinion that the increased facilities afforded by reduced tariff rates would lead to a very considerable expansion of the trade between the Far East and Western countries.—W. A. Rublee, Consul-General at Hongkong.

American Bar Iron in Australia.—As many complaints have been made to this Consulate regarding the quality of bar iron shipped from the United States to the Australian States, I addressed a letter to the leading importers requesting definite particulars, and received the following reply from one of the largest dealers in iron in the city Melbourne:

"The abnormal rise in the price of British bar iron at the beginning of the year 1900 furnished the opening for the introduction of American iron to the Australian market. There had been several parcels previously imported to this country, which had given modified satisfaction, but the importation was limited, and the few tons were not relied upon as indicating the average quality and finish of American iron. The various agents of American rolling mills speedily became alive to the fact that the British prices were $20 a ton in excess of the American, and a very large business resulted, as the Australian importers readily embraced the opportunity of buying merchantable bars at a figure which would leave them a large profit. The American prices continued to fall, owing to internal competition, and orders were diverted from the markets of Great Britain to those of the United States. The American rolling mills missed their chance, and instead of doing all in their power to secure the business of the Australian merchants for future requirements, evinced little interest in the orders they received, took their own time for delivery, and, instead of giving attention to the oversea demand, considered the home trade, which was already secured, first. They failed in every instance to comply with the requirements of the importers on this side—which were consonant with the methods adopted by British exporters—and followed their own will to their ultimate disadvantage. To add to the trouble thus created, the agents of the various New York shipping firms, anxious to secure freights and knowing little and caring less of the quality of the bars shipped, based their cost, freight, and insurance price on the cheapest rate for any quality of iron, and obtained large orders from Australian importers, the bulk of which have given great dissatisfaction. The result is that the American bar iron is not liked in Australia, its want of popularity being entirely due to the indifference of the American manufacturers.

"There are three qualities of American bar iron, viz.: Ordinary, refined, and a better quality still. The refined iron, if carefully rolled and uniform in quality, will meet all the ordinary requirements of this market, but the United States mills mixed their qualities, frequently failed to brand their own outturn, and paid little attention to the finish of their rolls, so that faulty rolling gave great inconvenience to the local manufacturers of implements and caused them to condemn all American iron. One other source of trouble was that the tariff in the United States for the making of special sizes was infinitely in excess of the British scale, and although some effort was made to reduce this enormous disparity, a very wide difference yet remains; consequently, no Australian importer has been able to gage with accuracy the relative values of the British and American iron, and has given his influence in favor of the former; and British manufacturers, seeing that there was a likelihood of the business going to America, promptly reduced their prices. Australian importers then endeavored to repudiate their contracts on the perfectly legitimate ground that the iron was faulty, not in accordance with specifications, and in many instances not iron at all, but mild steel; which latter, while useful for many things, does not answer all the purposes for which ordinary refined bar iron is used in this country. One case was tried in the Victorian courts, and the judge gave a verdict against the agent of the American company. The Belgians and Germans made an effort to capture the Australian markets, but owing to the cupidity of many manufacturers, who sacrificed quality for the sake of a few francs or marks per ton, their productions easily fell out of favor and very little is now imported into this commonwealth.

"There is one way in which the United States may rehabilitate themselves, and that is by holding large consignments in both Sydney and Melbourne, satisfying the buyers that the American mills are honestly anxious to meet the Australian requirements, and meeting all British and other foreign competition. Strict integrity must be observed in the fulfillment of all contracts, and if every other care is taken, it is yet possible for the United States to retrieve their position and command these markets; and as the trade of the commonwealth will increase by leaps and bounds, it follows that in a few years the market here will be a very solid factor to be considered in the American export of bar iron. Some points will of necessity have to be conceded, and among them are the faultless rolling of all bars and the throwing out of all bad ones. The tariff for extra sizes must conform to the British tariff. Bundles of bar iron must be made up in exactly 56 and 112 pounds, respectively, where so ordered, and the lengths must be within the limits named, even if the exact weights have to be made up with small pieces. This is necessary to avoid weighing each bundle. There will have to be strict uniformity in stocks, and prices must be kept within the limits of the British rates. Given these conditions, and large stocks held in stores in Melbourne and Sydney in the hands of a responsible representative, concessions in transport to other and smaller states, and uniform quality and rolling guaranteed, there will be an opportunity for the United States to obtain the trade and control the market of the Australian commonwealth."—John P. Bray, Consul-General at Melbourne.

Information Desired Concerning Charitable Work.—Consul-General Skinner writes from Marseilles, June 24, 1901:

Monsieur Léonce Conte, president of the Société Marseillaise de Patronage des Libérés et des Adolescents, desires information concerning societies in the United States which extend legal and material aid to foreigners charged with crimes or misdemeanors, or who are otherwise in difficulties. The Marseilles society has determined to organize a bureau to intervene on behalf of foreigners before the French authorities, and to aid them generally. Information and correspondence addressed to 19 Rue Friedland, Marseilles, will be gladly received. The need for such a society in every cosmopolitan city is beyond all question. The distress of stranded Americans, whether their situation be the result of wrongdoing or ignorance or accident, is the most frequent cause of inroads upon the personal resources of consular officers. No provision of law could be framed to meet such cases, no two of which are alike, and the scale of salaries established by Congress acts as a severe check to individual inclinations.

Cheap Lodging House in Milan.—A hotel or lodging house, after the style of the well-known Rowton Houses, of London, has been built and opened at Milan. The expense has been provided by a society formed expressly to furnish the necessary capital by means of donations. It was decided by the society to establish something in Italy on the order of the houses in London, but with such changes as the ground, place, and means would allow.

The hotel (located at the corner of Via Marca d'Oggione and Via Vallone) was opened June 18, and is now in working order. It was at first thought that the majority of the frequenters would be of the working class, but experience so far shows that almost the entire custom is composed of the poorer-paid clerks, shop assistants, and others of that class. It is restricted to males only. The cost of admission is 50 centimes per day (about 9½ cents), with an extra charge of 10 centimes (1.93 cents) for bed linen; but, on the other hand, lodging for a week costs 3.50 lire (about 67½ cents), without the extra charge for linen. Everyone must be in his room before midnight and out in the morning not later than 9 o'clock. Access to the bedrooms can only be had from 7 P. M. until midnight. Smoking is not permitted in the bedrooms, and the use of the electric lights is allowed only for dressing and undressing. No objects can be left in these rooms, separate closets being provided for personal clothing, while trunks, etc., are given room in the store closets. The bathrooms are open night and day for the use of the inmates—a complete bath costing 20 centimes (3.86 cents), while a shower bath may be taken for 10 centimes (1.93 cents). Food may be bought outside and cooked in the kitchens of the hotel, or it may be bought in the hotel at the cheapest possible price. Everyone may do his own washing or have it done for him in the hotel, at a fixed tariff.

The building is of five stories, not counting the basement and underground, while the roof forms a very extensive terrace. The architecture is extremely simple, but in good taste. The ground floor is raised about 5 feet above the level of the road, the main entrance to the hotel being on this floor, and an elevator serving to carry the inmates to the upper stories. From the atrium there are stairways leading to the upper stories and to the large rooms, which are reserved for dining, reading, and smoking. The dining room is the largest, best furnished and finished room in the hotel. It is of ample height, being from floor to ceiling 13 feet; it has wooden floors, and the walls are tiled to the height of 4 feet and 10 inches, and are painted in imitation of wood. The room is lighted by electricity. To this room are joined two kitchens, with heat always ready (known by the name of "economical kitchens"), and as stated above, each lodger can buy his provisions outside and use these kitchens, the hotel providing the necessary utensils and salt. There is a place to wash the meat, etc., before cooking, and to wash the kitchen utensils after using, all these places being supplied with running water.

The smoking room is also well painted and enameled, and has a wooden floor. The only difference between this floor and that of the reading room is that the latter is covered with linoleum. Nearby is a large room which serves as a wardrobe for the whole hotel. Each lodger has a separate wooden clothes closet, of which he holds the key.

The water-closets are numerous and well arranged, being located on each floor. On the underground floor, near to the bathrooms, are the washing stands, which are of marble slabs or tables, on which are fixed the basins. Each basin has a hot and cold water tap, also a discharge pipe underneath. There is also an arrangement for footbaths, each provided with hot and cold water. The baths and shower baths, for which a charge is made, as above stated, are as near perfection as the necessary economy would permit. The laundry, which is underground, is extremely practical and commodious.

There are 530 rooms (or so-called cells) in all. They are all of the same dimensions, viz., 5 feet 10 inches by 7 feet 6 inches. The height of the divisions between cells and corridor is 7 feet 10 inches, while the height from main floor to ceiling is 9 feet 10 inches. Each room has a window, measuring 4 feet 11 inches by 1 foot 9 inches. The furniture consists of a bed, chair, and clothes pegs; there is an electric light, to be used for the short time mentioned. The floors of these rooms, as well as of the corridors and the washing rooms, are laid in cement, and all the partitions are of hollow, cemented bricks, enameled as in the other walls of the building. The whole edifice is heated by means of hot-water pipes.—William Jarvis, Consul at Milan.

Trade of Chile in 1900.—Mr. Lenderink, secretary of legation at Santiago, sends under date of June 5, 1901, translation of the message of the Vice-President of the Chilean Republic at the opening session of Congress, from which the following statistics are taken:

The foreign trade of the Republic in 1900 amounted to $108,117,664 (viz., imports, $46,916,422; exports, $61,201,242), showing an excess of $9,798,894 over 1899.

Exportation of Cereals from Turkey Prohibited.—Under date of July 5, 1901, Minister Leishman, of Constantinople, sends copy of a note verbale from the Turkish Minister of Foreign Affairs, relating to the prohibition of the exportation of cereals from the district of Hay, in the vilayet of Bassorah. An exception, however, will be made to this measure in the case of cereals for the purchase of which contracts have already been signed. The United States minister is requested to draw the attention of his countrymen to this decision.

Demand for Beds in Tamatave.—Acting Consul Hunt reports from Tamatave, June 18, 1901:

I am requested by Mr. Christian Bang, of Tamatave, to invite correspondence with him in regard to camp or travelers' beds. He suggests such beds as are made in Racine, Wis. There is always a demand here for light beds of this kind—the lighter the better—by travelers going to the capital and other points on the island. Mr. Bang is one of the most prominent and oldest merchants here, as well as a regular importer of United States goods.

Dealings in Grain Futures in Austria.—Under date of June 17, 1901, Consul Warner, of Leipzig, says that the Austrian Council of Agriculture has unanimously declared itself in favor of prohibiting transactions in grain for future delivery. This action was taken as a result of a report submitted to the Council setting forth that suits cannot be brought to recover losses sustained in transactions for the future delivery of grain. The Council has petitioned the government to use its influence to suppress this practice, not only in Austria, but in Hungary as well.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Elastic, highly lustrous varnish is prepared, according to a note in the Seifensieder Zeitung, as follows:

1. To 100 parts of shellac varnish add 5 parts of Venice turpentine and 20 to 40 parts of spike oil; by the admixture of concentrated solutions of suitable tar-dyestuffs the varnish may be given any desired coloring.

2. Rosin 30, turpentine 20, oil-turpentine 30, sandarac 60, shellac 120 and spirit of wine (90 per cent) 900. The solution is filtered and colored with fine lampblack ground with spirit of wine.

To Color Wood with Aniline Dye.—For the purpose of imparting to wood an old appearance, G. A. Schoen gave various means in the Muehlhauser Gewerbeverein. Upon rubbing with aniline oil, the wood acquired a color resembling mahogany and very superficial. On the other hand a dark brown shade similar to that of old oak was immediately obtained by saturating the wood, first with a solution of aniline salt—aniline sulphate—and then with caustic soda. Similar results were obtained with walnut and plum tree wood. Caustic soda alone, it is true, had nearly a similar effect, but not so perfect as with the simultaneous use of aniline salt. Schoen also attempted to dye wood black by treating it in succession with aniline salt, potassium bichromate and caustic soda, drying the wood after each operation; the coloring thus obtained is very uniform. The process was successful with all varieties of wood experimented on, viz., the most important domestic and some foreign varieties. The coloring methods mentioned are quickly and easily done and are very cheap.—Neueste Erfindungen und Erfahrungen.

A Multi-Colored Metal.—About a century ago a newly-discovered metal was designated "chrome" in chemistry. This was done to call attention to the striking chromatic beauty of all its salts.

Exactly the contrary is implied by the oldest designations for silver. The Hebrews as well as the Greeks called it the pale metal, and the alchemists likened it to the pale light of the moon. Recent researches have demonstrated, however, that metallic silver is more multi-colored than metallic chrome. Barring violet, there is no color of the rainbow which cannot be produced with pure metallic silver.

If to a solution of silver in nitric acid that solution which is employed for developing photographic plates is added the metallic silver will separate again in the shape of a deep-black powder.

This well-known experiment has latterly experienced a very interesting change. Before pouring the developer to the silver solution, add a little pure glue to the latter. The precipitated metal will then not at once be of a black shade, but first it is yellow, then red, brown and finally it turns a pure blue in transparence.

Still other hues of pure metallic silver occur with the photographic printing paper known by the name of "pan-paper." According to whether the exposure is of long or short duration the color of the picture is red, brown, olive or green.

Hence, silver is probably the most multi-colored metal in existence.—Sueddeutsche Chemiker Zeitung.

Floor Waxes and Floor Glaze.—The waxing of floors is more and more adopted. While formerly a wax coating was applied only on the so-called parquet floors, it has now become a practice to wax painted floors as well. The object is to protect the paint for a longer time and to obtain a greater and more durable gloss. Where there are large children or none at all this process may be all right, but to small children waxed floors are very dangerous, and not seldom the children take such bad falls that they are maimed for life. This fact has been taken into account and so-called "floor enamels" are offered for sale, which possess the high luster of floor wax but not its slipperiness. Nevertheless, these enamels cannot be called perfect substitutes, since they are almost without exception spirit lacquers, which are known to offer little resistance to footsteps. Below will be found some practically tried receipts for both articles (floor wax and floor enamel). As regards the preparation of the wax compounds it is hardly necessary to mention that the greatest care must be exercised with naked fires, which frequently cause conflagrations. For the production of the enamel the so-called displacement process is employed, which requires a vessel with a sieve about one-half from the top and a tap at the bottom. The gums to be dissolved are placed on the sieve and covered with the requisite quantity of denaturized spirit. After a few days of settling the enamel can be drawn off below, which does away with the pesky and loss-entailing filtering.

WAX PREPARATIONS.

For Winter:	
Rosin	2,000 grammes
Yellow wax	4,000 grammes
Ceresine	1,900 grammes
Turpentine oil	40 kilos
For Summer:	
Rosin	2,500 grammes
Yellow wax	4,000 grammes
Ceresine	2,400 grammes
Turpentine oil	40 kilos

It is best agitated until perfectly cool and passed through a paint mill.

White Floor Wax:	
Carnauba wax	700 grammes
Rosin, pale	700 grammes
White wax	1,400 grammes
Ceresine, white	5,000 grammes
Turpentine oil	14 kilos
Solid Floor Wax:	
Yellow wax	4 kilos
Paraffine	36 kilos
Floor Enamel:	
Alcohol	10 kilos
Ruby shellac	3¾ kilos
Sandarac	½ kilos
Venice turpentine	½ kilos

—Seifensieder Zeitung.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.